King County

2004 GIS Software Migration Plan

Document History

Date	Who	Description
3/23/2004	GIS Technical Committee	**Document completed and discussed at the GIS Technical Committee meeting.**
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1 Introduction

1.1. Statement of purpose

GIS technology and associated data models have undergone radical changes in the last few years. The entire structure of geographic data has changed from a limited proprietary format to industry-standard RDBMS[1] format, allowing GIS data to be tied much more easily to business data. This key restructuring of the fundamental GIS data format, along with related changes, has spawned many new data models that can be used to describe and organize GIS and business data. But the magnitude and number of changes to software and data structure have resulted in increased complexity, requiring more technical expertise on the part of managers, analysts, and developers.

Organizations that rely on GIS to meet a wide variety of complex business needs, especially those that interact with other GIS practitioners, have little choice but to respond to the new GIS technology and data structure. Many of the external agencies that King County GIS works with have already migrated to the new software, or are in the process of doing so. The King County GIS Technical Committee has recognized the importance of adopting new technology, and has identified migration to ESRI's ArcGIS platform as a key concern for the KCGIS community.

The purpose of this document is to offer a comprehensive description of the software and hardware transition environment, and includes:

- discussion of issues relevant to agencies and the enterprise;
- a recommended training path for GIS staff and end users;
- recommendations on application transition and support;
- discussion of data migration issues and a recommended data migration path;
- a timetable, and identification of significant milestones to measure success.

The plan includes the scope of changes to GIS business practices, including changes to data, data maintenance tools, system operations, license management, and applications for query, analysis, and display.

This document does not include a comprehensive plan for migrating the cadastral base. This will be handled in a separate work plan.

[1] RDBMS – Relational Database Management System

1.2. Executive summary

The first two sections of this document outline the current status of ESRI's GIS technology and offer a narrative survey of agencies external to King County GIS that have completed or are in the process of completing their own GIS migration. The next three sections outline those issues that have been identified as important to King County GIS agencies and the enterprise as a whole. Sections 7 through 10 offer discussion and recommendations on the critical topics of data design and migration, licensing, training, and communication.

The final section details the plan for migration, and includes specific goals and tasks related to earlier recommendations, their responsible parties, timelines, and milestones.

1.2.1 Objectives and Milestones

There are four main objectives of the GIS software migration. When all of these objectives are met, the migration will be considered complete:

- The primary data warehouse (except cadastral base) is the read-only SDE geodatabase. The shapefile library is maintained for "legacy" ArcView 3.x users. The coverage library no longer exists.
- Data editing and posting takes place in the SDE geodatabase environment.
- Enterprise applications are in place to facilitate data access, management, and editing where necessary. Agency-specific applications are migrated or their relevant functionality integrated into other business applications.
- End users have been categorized and trained, and have either migrated to ArcGIS, ArcIMS, or have been declared as a "legacy" ArcView 3.x users.

To track progress toward these objectives, seven major milestones have been identified. Milestones are in rough time order; however, firm deadlines are not included as some may be completed in parallel.

1. Develop training curriculum. Sort all GIS users into categories. Develop a training curriculum for each user category, using available, cost-effective, and appropriate courses from ESRI classroom, ESRI Virtual Campus, KCGIS Center courses and modules, and other sources.
2. Complete preliminary data review. Conduct a fitness review of every internally-maintained coverage in the current GIS data warehouse (/plibrary). Layers that do not pass review should be archived and deleted immediately.
3. Create agency migration plans. Categorize agency business and technical needs into functional groups and prioritize based on common needs. Use this information and that acquired from agency needs assessment, data design, and geodatabase design and implementation to create a migration plan for each agency.

4. Implement prototype SDE production geodatabase. Implement and test a prototype enterprise SDE production geodatabase, using copies of core data layers. Ensure that stewards can connect to their data, edit it, and publish edited data to the data warehouse. Devise and publish methodology and appropriate guidelines for stewards, developers and analysts. Note that this will not include the cadastral data model, but will assume the presence of the parcel layer.

5. Optimize and migrate internally-maintained data to the production geodatabase. Determine layer dependencies and prioritize layers and layer groups to migrate based on agency needs. Design, implement, and test optimization processes based on a set of prototype layers. Optimize and migrate data. Remove migrated data from /plibrary.

6. Migrate front-end enterprise applications for data access and management. For each application included: determine need, design, implement, test and deploy. Create and publish user documentation.

7. Migrate users. For each user (or group of users, depending on the agency), determine the best migration path then implement.

1.2.2 Important points of interest and critical components to the plan:

- Software version: KCGIS will migrate to ArcGIS version 8.3.

- Phased migration: Agencies will migrate at different rates, depending on their business and technical needs, budget, number of users, and complexity of their internal data models. This will result in a mixed maintenance and access environment until all agencies have migrated. Goals and tasks for the migration are laid out in logical, time-oriented groups, with deadlines keyed to the adoption of the plan. Timelines are designed to be flexible enough to meet individual agency needs.

- Migrating the users: Agencies do not want, nor will be able to migrate all of their end users to desktop ArcGIS. Many users currently working with ArcView 3.x will be able to migrate to thin-client ArcIMS applications, others will need to install and use ArcGIS, and others will continue to use ArcView 3.x for the foreseeable future.

- Migrating the data: Data modeling for the production maintenance environment is of critical importance, and will be one of the major tasks facing agencies and the KCGIS Center. Implementation will require a high degree of cross-agency coordination, communication, knowledge of business needs, and technical expertise.

- Final data format and support for shapefiles: As the migration progresses, data maintenance will shift from coverage format to geodatabase format. Since coverages are no longer supported in the new environment, the coverage library (/plibrary) will eventually be rendered obsolete and subsequently abandoned. Shapefiles however, can and will be supported for the foreseeable future. Unlike coverages, shapefiles can be easily manipulated in ArcGIS, and will remain a primary data format for many end users for some time.

- Training: The creation of a flexible, cost-effective training plan that will meet the needs of agencies and users is of critical importance. A training plan and recommendations for curricula is outlined.

- Communication: A final essential component to the migration is communication. The KCGIS Center and the GIS Technical Committee will take the lead to ensure that communication is kept open among all members of the KCGIS community.

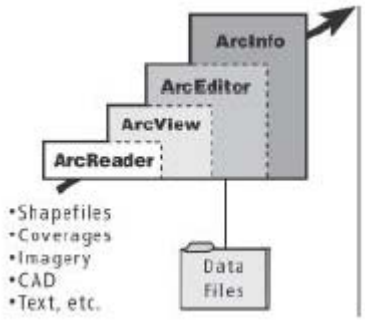
2 Overview of Current ESRI ArcGIS Technology

In 1999 ESRI released the first phase of their ArcGIS system. This represented a radical departure from the historically UNIX-oriented, server-driven, highly modularized command line environment to an integrated component object model (COM) architecture for GIS products. The new architecture provides a system that can be used to build and deploy GIS solutions and applications of all types within the Windows system architecture.

Statements made in this section are based on ESRI white papers and other documents (see references at the end of this section). As will be seen in later sections, some users take exception to some of the performance and functionality claims that ESRI makes.

2.1. ArcGIS Architecture

The new ArcGIS architecture is highly scalable. Users' software choice is driven by the level at which they wish to interact with their GIS, from mere viewing to full-blown maintenance and conversion tools. In the figure below (ESRI, 2003 (i)), each software includes the functionality of the one preceding it and offers additional functionality.



- ArcReader is a free lightweight product that allows users to view and print published map files (PMFs), which are created with a separate (not free) product, ArcPublisher.
- ArcView provides visualization, query, analysis, and basic data automation. Intended as a replacement for ArcView 3.x, it includes the same basic functionality, but offers a number of enhancements and is fully integrated with ArcGIS.
- ArcEditor provides the editing functions necessary to maintain data in a number of formats: shapefiles, raster, personal geodatabase, and multi-user geodatabase.
- Arc/Info provides all of the functionality listed above, with the addition of advanced geoprocessing, coverage editing, and data conversion capabilities.
- Extensions: The major Arc/Info and ArcView extensions have been or will be released in the new architecture.

Desktop access to the architecture occurs via three products. ArcMap allows users to display, analyze, and edit data, and create cartographic output. ArcCatalog lets the user locate and manage spatial and associated data, including personal and enterprise databases. Finally, ArcToolbox provides high-level conversion and geoprocessing tools.

2.2. The Geodatabase

Although ArcGIS will operate to varying degrees with existing data formats (shapefiles and coverages), it is fundamentally based on the geodatabase data model.

The geodatabase has two major concepts. First, a geodatabase is a physical store of geographic information inside a DBMS. The geodatabase follows the fundamental relational data model in which each object and its attributes are stored as a row in a table. An object represents a feature or a real-world entity that the GIS is designed to emulate (e.g., a parcel, a building, a streetlight,

a river, or a customer). Second, a geodatabase has a data model that supports transactional views of the database (versioning) and also supports objects with attributes and behavior. Behavior describes how an object can be edited and displayed, and includes, but is not limited to, relationships, topology rules, subtypes, and default values.

Three key features of a geodatabase are:

1. Centralized management of a wide variety of geographic information in a DBMS;

2. Versioning that allows simultaneous editing by multiple editors and transactional views of the geodatabase;

3. Custom (or intelligent) features that have behavior, topology rules, editing rules, and relationships.

Versioning allows simultaneous editing by multiple users and also allows transacted views of the geographic database. This framework allows the creation of versions of a geodatabase for the states of a project, the reconciliation of differences between versions, and the update of the master version of a geodatabase with the as-built design. Custom features can be enhanced with properties including behavior, editing rules, and relationships. As a result, they can more closely resemble real-world objects such as parcels, buildings, and transformers. (ESRI, 2003 (i))

Personal Geodatabase and Multiuser Geodatabase Comparison (ESRI, 2003 (i))

	Personal Geodatabase With ArcView	Personal Geodatabase With ArcEditor or Arc/Info	Multiuser Geodatabase
Number of concurrent editors	One	One	Many
Create and edit simple features (points, lines, areas, static annotation)	✓	✓	✓
Define and use attribute domains	✓	✓	✓
Set database schema	✓[1]	✓	✓
Versioning (long transactions)			✓
Store raster data			✓
Create and edit features with subtypes or dimension features		✓	✓
Establish behavior (topology, relationships, geometric networks, feature-linked annotation, etc.)		✓	✓
Create and edit custom features		✓	✓
Database size	≤ 250K features[2]	≤ 250K features[2]	Unlimited
Requires ArcSDE			✓
Supported databases	Microsoft Jet	Microsoft Jet	Oracle Microsoft SQL Server IBM DB2 IBM Informix

[1] Limited to simple features in a personal geodatabase.

[2] This is an approximate limit affected by two factors—file size and computer memory. Microsoft Jet 4.0 used by the personal geodatabase has a 2 GB file size limit. In addition, a personal geodatabase is a single file that is loaded into computer memory.

Therefore, performance can become unacceptable even for file sizes less than 2 GB. The recommended 250,000-feature limit is based on ESRI's experience with typical GIS data sets stored in a personal geodatabase.

2.3. Topology

Topology is implemented as a set of integrity rules that define the behavior of spatially related geographic features and feature classes. Topology rules, when applied to geographic features or feature classes in a geodatabase, enable GIS users to model spatial relationships such as connectivity (e.g., are all road lines connected?) and adjacency (e.g., are there gaps between parcel polygons?). Topology is also used to manage the integrity of coincident geometry between different feature classes (e.g., are the coastlines and country boundaries coincident?).

The integrity rules for coverage topology have equivalent rules in geodatabase topology. Yet there are a number of benefits with geodatabase topology that are not possible in the coverage model.

- Users define which layers participate in a topology.
- Multiple polygon, point, and line layers can participate in the same topology.
- There are a greater number of spatial constraints (topology rules).
- Users can specify which rules are appropriate for their data layers.
- Topology is stored in a multiuser, continuous, commercial off-the-shelf DBMS.
- Users can perform a partial build for increased performance. (ESRI, 2001)

2.4. Application Services

ArcSDE facilitates the storage and management of spatial data in a database management system. It is tightly integrated with ArcEditor and ArcInfo for designing, creating, implementing and sharing multiuser geodatabases. ArcSDE 8.x supports Oracle, Microsoft SQL Server and other databases.

ArcIMS is an internet mapping system that provides a framework for building and deploying GIS services and data from a central location to concurrent users. The web clients include both HTML- and Java-based lightweight browser viewers. The ArcGIS desktop applications can also operate as ArcIMS clients.

ArcPad is a lightweight solution for mobile mapping and field collection. It integrates with ArcGIS desktop, ArcIMS, and optionally with third-party GPS systems.

2.5. Customization

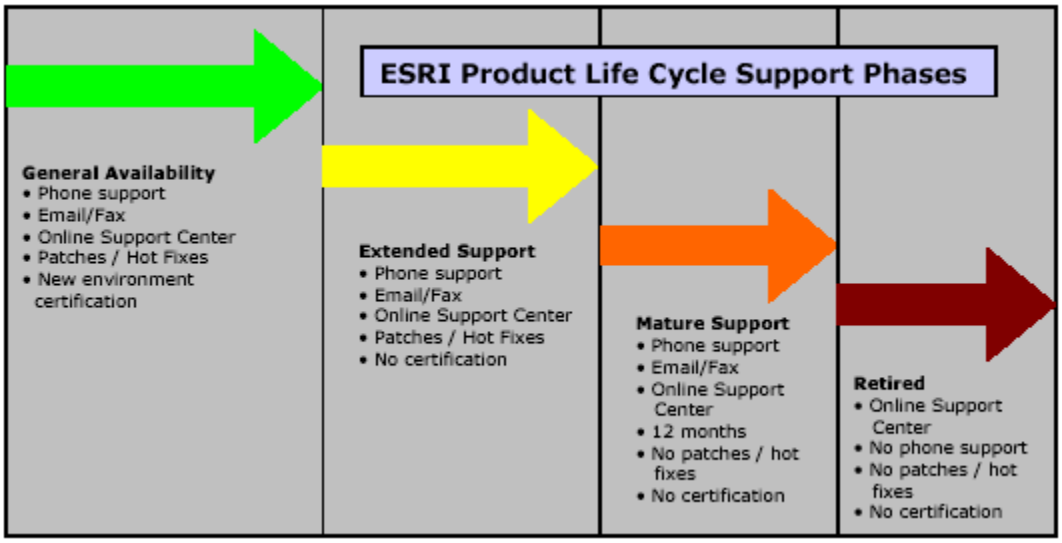
ArcGIS was built on a technology framework known as ArcObjects, which are a set of COM objects with programmable interfaces. This approach offers software developers the ability to customize ArcGIS and create applications using the same building blocks that make up the ArcGIS software. In addition, developers can use COM to extend the object model, thus extending the functionality of the core software.

VBA (Visual Basic for Applications) scripting is available with ArcCatalog and ArcMap, and more complex application development can be performed with any COM-compliant language, such as Visual Basic or Visual C++.

ESRI has also released an ArcObjects Developer Kit for Microsoft's Visual Studio .NET, which extends the ArcObjects Developer Kit released with ArcGIS 8.3, and allows developers to take advantage of the .NET environment.

2.6. Product Life Cycle Support

There are four different support phases of ESRI's Product Life Cycle, detailed in the graphic below (ESRI, 2003 (i))



Product	Current Support Phase
ArcView 3.3	General Availability
ArcView 3.2a	Mature Support
All other ArcView 3.x	Retired
ArcGIS[1] and ArcSDE 8.3	General Availability
ArcGIS[1] and ArcSDE 8.2	Extended Support
ArcGIS[1] and ArcSDE 8.1.x	Mature Support
ArcGIS[1] and ArcSDE 8.0.x	Retired
Arc/Info 7.2.1	Mature Support (Scheduled to retire when ArcGIS Desktop 9.0 ships. Version 7.2.1 will remain in this phase until Version 9.0 ships to provide users enough time to plan and execute their migration)
ArcSDE	
ArcIMS 4.0.1	General Availability
ArcIMS 4.0	Extended Support
ArcIMS 3.1	Mature Support
ArcIMS 3.0	Retired
MapObjects Windows 2.2	General Availability

MapObjects Windows 2.1	Extended Support
All other MapObjects Windows	Retired
MapObjects Java 1.01	General Availability
MapObjects Java 1.0	Retired

[1] Includes ArcGIS Workstation and ArcGIS Desktop

2.7. References

ESRI, Inc. (2003) "ArcGIS 8: The Complete Geographic Information System." http://www.esri.com/library/whitepapers/pdfs/arcgis8.pdf.

ESRI, Inc. (2003) "Product Life Cycle Support Policy." http://support.esri.com/knowledgebase/relatedDocs/ProductLifeCycle.pdf

ESRI, Inc (2002) "ArcGIS 8.3 Supports Visual Studio .NET" http://www.esri.com/news/arcnews/winter0203articles/arcgis83-supports.html

ESRI, Inc. (2001) *ArcNews Online*. "ArcGIS 8.3 Brings Topology to the Geodatabase" http://www.esri.com/news/arcnews/summer02articles/arcgis83-brings.html

3 Survey of Peer (External) Agencies

With the ever-increasing use of GIS in public sector organizations, it makes sense that surely some exist which had tried – and hopefully succeeded with – their own migration from Arc/Info 7.x to ArcGIS 8.x. With that in mind, we solicited experiences both directly and more generally through public list-serves. We were especially interested in speaking to representatives of large, distributed, public sector organizations that have attempted the transition to ArcGIS.

The results were mixed. While a number of agencies or their technical representatives responded, few considered themselves "fully migrated." Nearly all reported at least some difficulty in implementation, most commonly with SDE. However, most of them were satisfied with the way things were going, and looking forward to the next steps or phases of their own projects.

It should be noted that most agencies in this section were contacted in first or second quarter of 2003, and facts and opinions reflect this. For example, most agencies were using ArcGIS 8.2 and either were contemplating the move to ArcGIS 8.3 or had just made the move. It is highly likely that some situations have changed since that time.

3.1. Participating Agencies

- Seattle Public Utilities (City of Seattle)
- Resource Data, Inc. (Anchorage, Alaska)
- Oakland County, Michigan
- Indianapolis / Marin County, Indiana
- South Florida Water Management District
- Snohomish County, Washington
- Mecklenburg Co., North Carolina
- Kirkland, Washington
- County of Los Angeles, California
- Alberta Sustainable Resource Development – Land and Forest Division
- City of Groton, Connecticut.
- Sutherland Shire Council, Australia
- Dane County, Wisconsin
- Oklahoma Corporation Commission

3.2. Seattle Public Utilities (City of Seattle)

As a part of their GIS Tech Refresh project, SPU spent a year developing a pilot water utility geodatabase and editing application using ArcGIS. The overall goal was to better integrate their business systems and database with the City's GIS data layers. The main objective was to divorce non-spatial attribute data from GIS, so that they could be maintained separately.

The database design was straightforward. All replicated features were stripped out of the GIS layers, leaving only the ID and necessary GIS attribution. All business features were left in the business tables, which exist in two separate software systems: water distribution is maintained on Maximo software, and wastewater information is maintained on Hansen software. Both use Oracle as their RDBMS.

The general idea was to use the promised functionality of ArcGIS to make the business side of the system available to GIS without attribute redundancy or the need for synchronization. Maps could join to business tables and show live data, and editing applications could take advantage of ArcGIS's map-centric interface to streamline and ease the editing process of the business tables.

3.2.1 Biggest Challenge: Shortcomings of ArcGIS and SDE

While the theory behind their database design was sound, at least according to published ESRI documentation, SPU discovered upon implementation that the challenges and shortcomings of ArcGIS and SDE were severe.

Major problems and shortcomings of ArcGIS and the distributed database model:

- Versioned database tables cannot be queried outside of ArcGIS – this is a problem that the GIS Center Operations staff had trouble with as well, and is a severe limitation.
- External tables cannot be queried from within ArcMap – they lack ArcGIS required ObjectID field.
- Queries against joined external tables in ArcMap are prohibitively slow and tend to hang. Joined tables are fine for display, but if the joined table is open, the data cannot be queried.
- No spatial SQL queries from within an ArcGIS client.
- Inability to define feature subtypes with external attributes.
- Inability to use the ArcGIS attribute editor interface on external attributes.

SPU scrapped their distributed database model in late 2002. As of mid-2003, they were moving to Oracle's Spatial Data Object (SDO) geometry so that they can use Oracle's spatial queries. SDO is an expansion of functionality within Oracle, rather than a new data type, and it addresses many of the problems having to do with querying both spatial and non-spatial information. However, there are two major drawbacks to SDO: the first is that there are no editing tools – SPU would have to write all editing tools themselves, or pay to have it done; the second is a lack of validation rules – SDO has 6, whereas SDE has up to 120.

During the process, SPU hired ESRI to collaborate, and while they did get some useful information, their overall experience was disappointing. At no time did ESRI representatives indicate that the system that SPU was developing would not work, even as problems became increasingly severe.

SPU also contracted with ESRI to have a "systems design strategies analysis" performed. The process itself was valuable, as both an inventory and awareness exercise. Dave Peters from ESRI came to SPU twice over three months. The first visit was to assist in the coordination of effort among departmental DBAs, and define the process and expectations of the project. The second visit was the actual gathering of data. The final result was a document that very clearly defined current systems architecture and use (load), made predictions of project load over the next 5 years, and finally made hardware and software recommendations to deal with the predicted load.

SPU felt that the process and result of the systems inventory and load were quite valuable and well worth the money, but that the analysis fell somewhat short on the prediction and recommendation sections. Specifically, the system that ESRI recommended to SPU was

extremely cost prohibitive, and there were no suggestions for either alternate systems to do the same work (such as ganging commodity boxes), or less costly, scaled-down alternatives.

3.2.2 Current status

At the time of the interview with SPU, Mr. Rowley indicated that they were in the beginning stages of looking at alternate ways to implement their GIS technical refresh project.

3.2.3 Take-away information

- Versioned SDE databases do not work well with external database tables.

3.3. Resource Data, Inc. (Anchorage, Alaska)

Resource Data, Inc. (RDI) is an Alaska-based company that specializes in database, web, and GIS data and applications development. They have been working with Anchorage Water and Wastewater Utility for several years, and among other projects, have converted their GIS system (water and sewer system data and municipal parcel data) from coverages to SDE geodatabase running on Oracle.

Data that the agency did not own was imported without modification into the geodatabase, and set as read-only by everyone. Data that the agency did own was completely remodeled. They looked at every single coverage, determined which fields should go into the geodatabase and which actually belonged to a work management system (for example valve location was GIS, but status was work management).

They then spent four months doing a key reconstruction between the old and new systems and working out problems generated by the lack of synchronization between the two redundant legacy systems.

The Utility wanted to distribute editing beyond their GIS shop. The solution was to use ArcEditor and house all tables in a versioned geodatabase that is compressed three times a week. Even though there is only one version, it *is* a versioned database, and this has had implications on the back end, most notably with key integrity.

Since there are many people with editing responsibilities, there is a greater feeling of ownership of the GIS database, which has resulted in a push for more data and use. They've since expanded the available data, adding information from planning projects.

3.3.1 Biggest Challenge: Implementing the versioned SDE geodatabase

Implementing a versioned geodatabase resulted in nonstandard database keys, which meant that they no longer have a standard Oracle configuration. After spending several weeks trying unsuccessfully to use alternate keys with Oracle's autonomous triggers, they decided that there was not going to be any achievable way to have an alternate primary key for business use incorporated into the SDE database.

They looked at ESRI's suggestion to apply database rules and tools to every user, but this created too many other problems, and deploying editing restrictions to so many users is an unwieldy and time-consuming solution at best.

Their final workaround was to trust the ObjectID in the spatial tables as a primary key, and provide a foreign key to the business tables, without enforced uniqueness. This causes occasional problems, for which they have set up audit processes. They did not try to do it the other way – that is, put the ESRI ObjectID into the business tables as a foreign key.

RDI has also encountered the inability to query back and forth between versioned SDE geodatabase and external Oracle tables, as well as the unacceptable slowness when querying against a joined spatial/business layer. Their solution has been to create a set of materialized spatial views of the SDE layers. A materialized view is one that can precalculate joins, thus improving query performance. RDI was able to set up some scripts and let them run on a regular basis.

Since the materialized views encompass the same five SDE tables for each featureclass, neither ArcMap nor ArcIMS recognize the difference. Display time for users (including ArcIMS) is the same as for non-joined data. And despite the fact that ESRI software occasionally pops up with a message specifying "non supported view" it still works fine for them.

3.3.2 Current Status

The Utility has been live with the new system since October 2002.

3.3.3 Take-away information

- Versioned SDE databases do not work well with external database tables.
- In order to get around the query and display limitations of versioned databases, create materialized views of the SDE database in Oracle and point (non-editing) ArcMap and ArcIMS clients there.

3.4. Oakland County, Michigan

Oakland County's GIS migration plan was developed in 2002. Three key areas that were identified at that time were desktop architecture, central service architecture, and GIS data architecture.

The Oakland County plan consists of three phases:

- Phase 1 establishes the necessary key technologies. Desktops will be upgraded to meet the standard, and central GIS services will be better implemented to promote more widespread data access.
- Phase 2 migrates current GIS applications to ArcObjects and ArcIMS environments. Also, Phase 2 will see the development and testing of geodatabase prototypes
- Phase 3 is the migration of current data to geodatabase. Data maintenance tools will be rehosted in the ArcObjects environment.

GIS users across the enterprise were initially identified, and each was categorized into one of four "roles," depending on their GIS use. Each role has associated with it a desktop hardware and software setup. The developed training curriculum is in synch with the migration.

Applications which are used in a single agency will be rehosted as "thick-client" ArcObjects applications to be included in desktop architecture. Other applications, such as that deployed in their "parcel kiosks" will be redeployed as ArcIMS applications hosted on a central server.

Data will be organized into one read-only SDE "publishing" environment that is available for mapping and analysis to all users, and multiple SDE production (editing) environments to implement the different sets of topology rules that will be needed. For instance the land management instance will house parcel, road centerline, site address and election layers.

They have had their read-only SDE publishing database implemented for some months now so that users can get used to connecting. The SDE production database for their infrastructure information is also up and running. They are currently designing their parcel model and working up an implementation plan, as well as developing productivity tools in ArcObjects.

The best solution for them appears to be a modified version of ESRI's Parcel Data Model. However, the questions of versioning, disconnected editing, and synchronization are still on the table, as they want to take advantage of related tables, object classes and triggers within the parcel editing process.

They have implemented ArcGIS 8.3 and ArcSDE 8.3, and will not likely upgrade to 9.x until they have finished their migration.

3.4.1 Biggest Challenge:

Data modeling

3.4.2 Current Status

As of early 2003, Oakland County is well into their migration. While some of the steps and specifics of their plan have changed, the fundamental concepts and objectives are still valid. They are currently in Phase 3, dealing with data migration and cleanup.

3.4.3 Take-away information

- Employ one SDE instance for data warehouse, and additional SDE instances for editing the various groups of related data. Organize by topological need and coordinate across agencies to create the topology rules, ensure synchronization, and facilitate communication when editing layers.

- Hardware and software standardization is important – the type of GIS use will determine what type of desktop environment is implemented for a given individual.

- Training is a key factor in ensuring that users can access and use the tools that they need in a timely and efficient manner.

- Categorizing users into well-defined groups allows standardization of hardware, sofware and training.

3.5. Indianapolis / Marin County, Indiana

The City of Indianapolis/Marion County has a large, robust GIS, with over 500 users. They are in their second attempt of migrating their software, and so far they've moved 300 casual users off of ArcView 3.x and onto ArcIMS.

They did a sizing exercise before they bought their new servers, and unfortunately weren't able to afford the hardware that they needed. They ended up buying two large SDE and three large ArcIMS servers, and will add new CPUs and licenses as funding permits.

One of the SDE servers houses data viewed by all users and ArcIMS; the other is for data editing. They're currently setting up data replication between the two. They do not currently edit in SDE, so there is no need for versioning.

The parcel layer is currently stored and maintained in ArcStorm, with only one person tasked for editing. Nightly automated processes extract the ArcStorm data to shapefiles, which are cleaned up in the PC environment and posted to SDE. Other GIS data is stored in personal geodatabase, shapefiles, and coverages.

So far, there has been no need to replicate their AML in the ArcGIS environment. With the exception of the AMLs used to edit their parcel data, they have discarded all of their AML code, and have discovered that so far the ArcGIS environment is adequate for editing their non-parcel data. End-user applications built for ArcView 3.x are being evaluated, and there is an expectation that at least some of them will be recreated in ArcGIS to maintain interface continuity.

Business and spatial data are still separate. They tried a few years ago to integrate their sanitary/storm sewer spatial and business information, but had to abandon the project due to limitations of SDE and the geodatabase model. The company providing their attribution software (Hansen) was not cooperative in the effort to link the two systems. Currently, the GIS layers are still separate from the business attribution. Layers needed to create maps are stored in GIS, and the rest are stored in the Hansen software. GIS staff perform extracts as necessary for analysis.

They've discovered that the key to successful support from ESRI is to talk to the right person. They'd gotten frustrated with the level of service for ArcIMS support, so they went out and spent a couple of days at ESRI.

3.5.1 Biggest Challenge: pulling everything together

Since they have an outside vendor for IT support (OS, Oracle, servers, desktop), coordination can be an issue.

3.5.2 Current Status

Determining methods for implementing SDE for users; implementing ArcIMS solutions for casual users

3.5.3 Take-away information

- Our contact highly recommends moving to Arc8.3 over 8.2. Version 8.3 is much more stable, it can access data created in earlier versions, and topology rules do not have to be implemented until later.

- One way to determine which applications will need to be migrated is to give your end-users a chance to use ArcGIS "as-is" – the ArcGIS 8.x interface may make some AML and Avenue applications unnecessary.

3.6. South Florida Water Management District

South Florida Water Management District (SFWMD) is a regional agency covering 16 Florida counties, and is currently charged with the Everglades Restoration. They are in the process of converting their Arc/Info coverages into personal geodatabase and SDE, and hope to be completely off of the Arc/Info and ArcView 3.x platforms by June 2003.

The system they are coming from consists of 4000 coverages that are maintained in Arc/Info and approximately 1000 ArcView documents for display and analysis. Business data is housed in an Oracle database. Data is connected by nightly AML routines that concatenate two Oracle fields to create a primary key that is appended to the coverages.

The most time-consuming part of the project has been the data scrub, in which each record in every business table and GIS coverage is evaluated (amounting to about 28,000 GIS and an additional 8000 business records). Redundant items are resolved by dropping the field on the GIS side, and conflicts are resolved as they appear. Empty fields are removed. Much of this has been dealt with programmatically, but there has still been a significant time investment of manual checking.

The processes and rules for the data scrub were meticulously thought out and documented before it began. Except for critical projects, the entire GIS operation was halted for six weeks while the data scrub was taking place. Every member of the GIS staff was tasked with this project, which increased efficiency. Because of the time taken beforehand to define exact processes, and their ability to concentrate staff resources, they feel that the data scrub has been a big success on all fronts.

SFWMD is implementing SDE 8.3 on Oracle for the six enterprise layers. This will be a single-user versioned database that will allow for management oversight. The rest of the data will be in personal geodatabase format, and will be scattered among the steward agencies and connected with a workspace server. They will use ArcGIS 8.3 for editing and some analysis, and hope to set up an ArcIMS site for viewing and analysis.

Since they have limited GIS programming resources, SFWMD has hired a consultant to build a custom interface for ArcGIS 8.3 that will update their Oracle business attributes through ArcMap. While they haven't seen this approach in action, their consultant feels confident from the provided specifications that the application will work.

3.6.1 Biggest Challenge: The data scrub process

SFWMD has not yet finished its conversion process, but from what they've seen, they do not feel that the software and the applications will be a problem. They like the functionality offered in ArcMap and are confident that it will meet their needs.

3.6.2 Current Status

SFWMD has completed the data scrub process and is beginning the process of designing their database. They have not yet implemented the new design.

3.6.3 Take-away information

- Expending the effort to make the data right the first time is worth the effort.
- One possibility for database design is to use SDE for "core" layers, and personal GDB for everything else.

3.7. Snohomish County, Washington

Like King County GIS, Snohomish County GIS is a large, distributed multi-departmental operation with a central enterprise group. Like us, they maintain a large master database with key datasets stored in coverage format, and like us, they use Arc Librarian in a limited fashion to assist with organization.

After recently completing a comprehensive reevaluation of their GIS program, they have structured a multi-stage plan, and are now in the preliminary stages of a software migration.

The first stage involves a pilot implementation and evaluation of ArcGIS desktop software (version 8.3) with departmental technical representatives – this group will form their migration team. The results here will determine their training plan for the rest of the GIS staff and users. At the same time, central GIS will get up to speed with personal geodatabase and SDE on SQLServer, and ArcIMS. During the next stage, they will roll out the ArcGIS desktop software to everyone who wishes to move forward, and offer the necessary training. Central GIS will move their coverages into SDE as is. The next stage deals with data modeling and refining the new SDE layers to make them as viable as possible. The departments will be heavily involved in this process, including the process of data modeling. Finally, they will move into full production mode with SDE and desktop ArcGIS.

Estimated total time is on the order of 2-4 years.

The goal is to reduce the 170 ArcView licenses to about 50 concurrent ArcGIS licenses; hopefully, ArcIMS can meet the needs of many of the current ArcView and ArcExplorer users.

While there is an understanding that ArcGIS will allow a better integration of business and spatial systems, there is still the concern over cost – neither the county managers nor the GIS staff wish to repeat the frustrations and costliness that they experienced during their parcel conversion.

3.7.1 Biggest Challenge:

Unknown at this point

3.7.2 Current Status

Just beginning the implementation of the migration plan. Central GIS is experimenting with desktop ArcGIS, personal geodatabases, and SDE.

3.7.3 Take-away information

- Having the affected departments buy in to the migration plan and its implementation is crucial.

3.8. Mecklenburg Co., North Carolina

GIS development in Mecklenburg County has paralleled our own. Like King County, they had a lengthy initial conversion from paper to digital cadastral mapping: theirs was finished in 1999, and they caught up to current work in 2000. They also have a complex, extensive annotation setup which is widely used for mapping, and a complex set of AML routines to control updates. Their initial conversion was using Arc/Info on UNIX, with Oracle, and they have recently moved most of their operation to ArcGIS and SQLServer.

Unfortunately, they have not been successful in their transition to full-use of ArcGIS and SDE. They have found that the annotation is difficult to update and does not display well in the ArcGIS environment, with the result being that their data warehouse consists of a single non-versioned SDE instance. Editing takes place in the workstation environment: layers are checked out of SDE, edited in Arc/Info, then checked back in to SDE.

They have very recently upgraded to ArcGIS and SDE version 8.3 and are hoping that this will allow them to fully implement the Parcel Data Model that they've developed.

3.8.1 Biggest Challenge:

Annotation layers

3.8.2 Current status:

Just moved to ArcGIS and SDE 8.3, and are beginning the evaluation process.

3.8.3 Take-away information

- Annotation is a potential showstopper in ArcGIS 8.2 and earlier. Whether this is true in 8.3 remains to be seen.

3.9. Kirkland, Washington

The City of Kirkland began their migration from ArcView 3.x and a shapefile environment to ArcGIS a few years ago. Since then, they have successfully implemented ArcSDE on SQL Server, ArcIMS, ArcGIS desktop, and ArcPad.

Their major layers, including their parcels, are housed and edited in SDE 8.2; since they only have one person editing, they do not use versioning. In addition, they use SDE to house more

than 30 GB of high-resolution raster data. They intend to migrate to ArcGIS 8.3 in the near future.

Since users are being allowed to migrate their desktop software at their own pace, some data layers still exist in shapefile format

One of the biggest successes for Kirkland GIS has been the implementation of ArcPad for field use. After an initial skepticism, field crews have embraced the technology, and there are multiple data collection projects on tap for summer 2003.

Another success has been the implementation of a layer (.lyr) file library. This helps users maintain cartographic consistency, saves them time, and reduces frustration.

3.9.1 Biggest Challenge:

Education and training, and getting the right tool for users. Analysts were trained first, and then given the opportunity to practice with the software so that they could answer technical questions from users. Most user training was in-house, peer-to-peer.

Also, raster plotting is still problematic as ArcPress does not release its license automatically – the user must uncheck the extension to release the license for the next person.

3.9.2 Take-away information:

- Layer (.lyr) files with standard symbology and templates help alleviate user frustration.

3.10. County of Los Angeles, California

LA County migrated from coverages to geodatabase in April 2002. Prior to that, they used Arc 7.x, then ArcGIS 8.1 to edit 3100 separate workspaces, each containing one coverage representing one page of the Assessor's Map Book. The current geodatabase currently houses information for 2.3 million parcels. A related table with property attribute information exists in a separate database.

They use SDE 8.2 on SQL Server and ArcGIS to edit the versioned database, and except for encountering slow speeds mostly due to ageing hardware, are pleased with the stability of the geodatabase. Their geodatabase is versioned, and they synchronize with daily reconcile and post operations.

By installing eight computers running an ArcIMS parcel search website, the Assessor's office has greatly reduced staff time at the map counter.

3.10.1 Biggest Challenge:

Unknown

3.10.2 Current Status

Building applications to extract information and produce custom maps.

3.10.3 Take-away information

- Large versioned SDE databases can work.

3.11. Alberta Sustainable Resource Development – Land and Forest Division

Alberta's Sustainable Resource Development (SRD) is a large, very distributed organization with both a central and regional offices. The regional offices maintain an autonomy that makes reporting and standards enforcement difficult.

While some of the other divisions of the SRD have started their migration, the Land and Forest Division is taking a slow and cautious approach to migration to ArcGIS and do not expect to fully migrate until version 9.0. They're training their power users first so that they can support the casual users when the time comes. Their current thoughts are to not migrate their AML code, as it is still useable in the ArcGIS environment; however, they will need to convert their Avenue code.

Cost is an issue, as is connectivity among the regional offices. SRD is using Citrix servers for licensing and application distribution, including ArcView 3.x (ESRI is on board with this setup, as long as licensing and use are monitored). Citrix is a thin-client application server software, which works well when there are many distributed users and/or slow connections. SRD has found that their Citrix setup has low annual maintenance costs, and has allowed their smaller and cash-strapped users to buy in to GIS cheaply and easily. While a few power users still keep local copies of software, casual users access spatial data via Citrix.

Their IT group has also piggybacked Oracle onto the Citrix servers, and they have an SDE instance that houses their base data. SRD has found Citrix to be an excellent way to deploy Oracle applications and to provide access to their many Oracle databases. They use SDE strictly for data access and not editing, so versioning issues have not come up. Eventually, their ArcIMS applications will use the SDE data as well.

They suggest that a good IT person is a necessity when setting up the Citrix server as there are numerous patches and tweaks that can be made that will increase efficiency. They've found Citrix's parent company to be responsive to their needs.

3.11.1 Biggest Challenge: cost

SRD is looking at upgrading over 100 ArcView licenses. SRD continues to undergo funding shortfalls which magnify software cost issues.

3.11.2 Current Status

SRD is at the beginning phases of their migration. They are currently migrating their internal ArcView course from 3.x to 8.x and hopes to offer the first ArcView 8.x in the next fiscal year. GIS staff are being encouraged to learn the new ArcGIS desktop tools now in order to be in a position to support other end-users upon migration. Migration is generally planned for ArcGIS 9.0, although ArcView 3.x will continue to be used by many staff for some time to come.

3.11.3 Take-away information

- Citrix servers offer a cheaper alternative for distributing application deployment. However, setup can be a bit tricky.

- When dealing with a license server (such as theirs on Citrix), make sure that all users register with the same client number, or the results will be the creation of multiple unneeded primary and secondary licenses, resulting in unnecessary costs.

3.12. City of Groton, Connecticut

While the City of Groton GIS is much smaller than that at King County, it has dealt with many of the same problems that face us. They recently moved their data off UNIX to NT, and have upgraded from ArcView 3.x to ArcGIS 8.3. They have an intranet installation of ArcIMS, which is used by about 35 people as their primary source of spatial information.

All spatial data has been migrated to personal geodatabases in ArcGIS 8.3, except parcels, which still reside in coverage format due to topology difficulties and annotation issues. Their AML tools have all been rewritten in Visual Basic, and they use Crystal Reports for lists and reports. They are currently investigating the new topology rules and editing tools, and are optimistic.

They connect their property tax information to the GIS via static snapshot.

3.12.1 Biggest Challenge

Getting users to switch from the familiar ArcView 3.x to ArcGIS 8.3 was a challenge, as was getting them to access central data instead of keeping local copies. The hardware upgrade was also a challenge.

3.12.2 Current Status

Determining methods for implementing SDE for users; implementing ArcIMS solutions for casual users.

3.12.3 Take-away information

- End-user buy-in is necessary, but it may be difficult to get them to use centrally located data .

3.13. Sutherland Shire Council, Australia

Last year the Sutherland Shire Council converted about 30GB of information (5000+ maps plus imagery) from GenaMap to ArcGIS. They intentionally took a long conversion path – GenaMap to shapefile to coverage to personal geodatabase to SDE. This allowed their new ESRI users to get used to the software, and more importantly allowed a “staged” conversion with plenty of opportunities for QA and validation. It also allowed them to prioritize their data for conversion and get their critical layers finished and validated before dealing with other layers.

Their data now resides in SDE and personal geodatabase; however, there is a push to get all core spatial data into SDE. They have versioned the database, but as our contact no longer works for the Council, he was not able to provide complete status of that effort. He did say, however, that

they were setting up under ESRI's guidance, and were implementing a very straightforward instance.

3.13.1 Biggest Challenge:

A very tight and hard deadline for the conversion.

3.13.2 Current Status

Unknown.

3.13.3 Take-away information

- Personal geodatabases are a viable interim step for storage and access of spatial information. Large amounts of data can be easily organized and accessed until more formal data models using SDE can be created and implemented.

3.14. Dane County, Wisconsin

In their published Migration Plan document dated May 2002, Dane County stated its intention to migrate their ArcView 3.x users onto ArcGIS in a phased approach. Data will be moved to SDE, and ArcView 3.2 users will be upgraded to ArcView 3.3 to be able to access SDE while longer-term solutions are developed.

The ultimate goal is to have as many users as possible using the thin client ArcIMS software for access and analysis, while data stewards maintain spatial data using ArcGIS desktop software

3.14.1 Biggest Challenge:

Unknown.

3.14.2 Current Status

Unknown.

3.14.3 Take-away information

- Using personal geodatabase as an interim format while the new data model is being designed, developed, tested, and implemented is a possibility.

3.15. Oklahoma Corporation Commission

The migration at OCC was a drastic enough change that it can be considered a ground-up implementation. After interviewing users about their GIS use and needs, GIS staff upgraded a number of the 100 or so ArcView 3.x copies to ArcView 8.0, with the intent to move to 8.2 when it came out. They do not have SDE, but export business data stored in Oracle programmatically every three days.

3.15.1 Biggest Challenge:

Consolidation of existing data; creating new data; training users; converting scripts

3.15.2 Current Status

Unknown.

3.15.3 Take-away information

- Personal geodatabases work.

3.16. Themes

A number of themes surfaced, although the responses and opinions sometimes varied widely.

3.16.1 SDE

SDE usage varied from not at all to full versioned implementation for editing of production data. Only two of the participants (RDI, LA County) use versioned SDE to directly edit spatial data, and those were not without problems. The rest either use SDE for read-only data warehousing, or not at all. Many are taking a wait-and-see attitude so that they can avoid pitfalls.

Data warehousing seems to be the most successful application of SDE. A read-only instance with broad access can be successfully implemented before dealing with editing conversions and maintenance issues, and is a good way to get more users accustomed to the idea of accessing spatial data in a format other than shapefiles. However, mechanisms must be put in place to keep the new data warehouse synchronized with the older data formats until more permanent measures can be put into place.

One common theme was that SQL Server is cheaper and easier to maintain for SDE than Oracle. While there may be performance issues, no one had anything negative to say.

One interesting implementation for dealing with the basic inability to create separate editable "data sets" in SDE came from Oakland County (MI), where multiple instances of SDE have been set up to accommodate the various logical groupings of layers for editing. The instances are organized by topological need and coordinated across agencies to create the topology rules, ensure synchronization, and facilitate communication for editing purposes.

3.16.2 Versioning

Both of the agencies using versioned SDE have set up a single user – no one has implemented a multi-user instance. In addition, those who have tried to connect SDE tables to external business data have had difficulty. In particular, versioned database tables cannot be queried outside of ArcGIS, and external tables cannot be directly queried from within ArcMap. While it is possible to join/relate to external tables in ArcMap, this is problematic as the response time for queries is prohibitively slow. Finally, editing across a join in ArcMap is just not possible.

One respondent, RDI, made their own workaround to the inability to edit external tables from within ArcGIS by creating foreign keys to the ObjectID in the business tables. This does create occasional synchronization problems, as this creates a nonstandard Oracle implementation, but they have put mechanisms in place to recognize and flag the problems for correction.

A common solution to the problems of versioned databases is not to use them unless necessary. Many agencies have had success in implementing SDE for a handful of "core" layers, and using personal geodatabases for the rest.

3.16.3 Training

All agreed that the right training at the right time is crucial for all concerned. Unfortunately, the problem was figuring out what is the right training and when is the right time. Many agencies trained their analysts and "power users" first and used a more informal peer-to-peer type of training for their users. Another solution was to categorize users based on need and offer a set of standard in-house and external training opportunities for each category.

3.16.4 Other Observations on Implementation

Nearly all of the agencies that participated were either in the planning stages themselves, or more likely, somewhere in the middle of their own migrations. Apparently, there are currently very few agencies that are using ArcGIS and ArcSDE to maintain and edit their spatial data in versioned geodatabases. The two agencies that are using versioned GDB to edit do not have multiple users. Additionally, at the time of contact, none of the agencies contacted was using topology capability associated with ArcGIS 8.3, and none was using geodatabase rules and relationships.

Most of the agencies that use SDE are not using it to edit production data; rather they tend to use it – successfully – as a read-only data warehouse. In this context, it seems that Oracle and SQL Server work equally well.

Migration offers a great opportunity to revisit data. Numerous agencies took the time to do heavy-duty QA/QC work on their existing spatial and business data before moving it into SDE, and none regrets the investment.

Those agencies that are reporting the most success have implemented a phased migration. They tend to migrate their staff first, then their desktop users, then their data "as is" into SDE. If there's going to be a data QA/QC effort, it occurs at this time. Parcel data is invariably saved for last. Applications are generally built starting sometime before the migration of desktop users, and are generally in place by the final data push.

There was general agreement that ESRI can be a lot of help in designing and implementing a migration; however, careful selection of the type of help and the technical persons involved is necessary.

The agencies that are implementing thin-client (ArcIMS-type) applications agree that this type of deployment seems to work better for most casual users. Deploying data for casual GIS users via ArcIMS reduces the number of desktop ArcGIS installations (thus saving agencies time, money, and administrative overhead) and allows wider access to GIS data.

ArcObjects is widely regarded as having a steep learning curve, and is difficult to work with and deploy. Many analysts and certainly no casual users will not have the time, inclination or skills to gain enough proficiency to make it useful in their everyday work. ArcObjects should probably be used only to develop applications for power-users (stewards and non-casual analysts).

Annotation in ArcGIS is still problematic.

Finally, nearly all of the agencies contacted said that they were either using ArcGIS 8.3, or intending to upgrade to 8.3 at some point in the future. No agencies expressed a willingness to wait for version 9.x, and most had a more relaxed attitude toward migrating to 9.0, since it seems to be a less major upgrade than 8.3.

3.17. Conclusions

1. Training needs to be timely, cost-effective, well planned, and customized.

2. Phased migration works well, especially when large numbers of users are involved. The timing for data warehouse (read-only) implementation, and application development can be more flexible, and generally should fall somewhere in the middle of the timeline. If users are to be allowed to migrate at their own pace, alternate forms of data (e.g., shapefiles) must be retained and kept synchronized.

3. Any plan that involves editing using versioned SDE needs to be very carefully designed and tested before implementation. While most of the problems that organizations encountered were using version 8.2 of SDE/ArcGIS, there is not yet enough evidence that version 8.3 will sufficiently alleviate these problems.

4. ArcIMS is a desirable GIS deployment mechanism for low-use, non-editing and/or occasional users.

5. Personal geodatabases can be helpful, especially as a interim step in data conversion.

6. ArcGIS 8.3 is the version of choice.

3.18. Acknowledgments

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4 Survey of Internal Agencies

A successful software migration cannot take place without meeting the needs of the KCGIS member agencies.

It should be noted that the agencies in this section were contacted in first quarter of 2003, and facts and opinions reflect this. In some cases, technology needs and use, and possibly GIS business needs have changed. Because of this it is recommended that agencies perform a business needs analysis (of scope to be determined) before embarking on migration (see Section 11.6).

4.1. Procedure

Each of the seventeen members of the GIS Technical Committee (sixteen member agencies and the KCGIS Center) was contacted in early 2003 to set up an interview date with either themselves or their delegate. Representatives were encouraged to invite others to provide technical or business clarification.

Respondents were sent the first section of the survey (entitled "Current"), for which preliminary answers had been filled in as much as possible from the 2003 King County GIS Operations and Maintenance document. The rest of the survey was provided at the interview. This approach saved time on both fronts. The opportunity to view the first, more factual and objective, section of the survey allowed respondents the time to verify and augment facts from materials at hand. Withholding the rest of the survey allowed for a more conversational, discussion-oriented session. Respondents were sent a copy of the notes and encouraged to make corrections, clarifications and updates. See Appendix B for survey questions.

Agency abbreviations and use levels used throughout this document can be found in Appendix A.

4.2. Survey Questions

The questions of the first section (titled "Current") deal with current use of GIS:

- GIS business use and current budget
- Hardware and licenses
- Staff: number, training, support, GIS staff vs. end users, GIS use by product and use levels
- Applications: use of enterprise applications and in-house application development
- Data: connectivity to enterprise data, in-house storage and maintenance, connecting business data to GIS data

The questions in the second section (titled "Future") deal with two concepts. The first is general change and challenges in the agency and its GIS business in the next few years:

- Change in GIS business definition
- Change in budget situation
- Change in staff

The rest of the section concentrates on issues specific to the software migration:

- GIS staff and users' awareness of ArcGIS functionality

- If the agency has begun migrating already: status, timeline, changes incurred
- If the agency has not yet begun migrating: intent, timeline
- Perceived challenges and effects on GIS business
- Data: use of SDE, the geodatabase, and the planned enterprise data warehouse; in-house data and RDBMS; perceived challenges
- Applications: effects on in-house applications; "wish list" for ArcGIS-oriented enterprise applications
- Desired support levels from the KCGIS Center

A complete text of the survey can be found in Appendix B, and comprehensive results can be found in Appendix C.

4.3. Summary of Survey Results

4.3.1 Business

Six of the seventeen respondents expected no change to their GIS business definition in the next few years. Of the rest, five expect to see better use of GIS in the agency, and hopefully better integration of GIS into other business within the agency. One (OEM) expects a dramatic increase in workload due to an expanding user base, and one (Transit) is undergoing a significant change of GIS business practice due to a planned hardware migration.

No agency expects a radical change of staff, although a few agencies mentioned the possibility of hiring interns if workload warrants the need.

One of the biggest challenges to agencies in the next few years with respect to GIS will be the migration to ArcGIS and dealing with the new technology it represents (6 responses). Other common challenges are better utilizing GIS in the agency and better integrating GIS into business functions; dealing with data issues; and dealing with budgetary strains.

4.3.2 Hardware

As expected in a highly distributed environment, a wide range of hardware can be found among the agencies. In general, users tended to have lower-level workstations, while developers tended to have faster, beefier machines. Nearly all were using Intel-based hardware running some version of Windows. Most were on NT, 2000, or XP, with a few at 98. The cartographers in KCA use Sun workstations.

Eleven of the seventeen agencies house GIS data on local servers, nearly all Windows-based. Transit is in the process of migrating its GIS operation to Windows servers; and the KCGIS Center maintains the enterprise UNIX server. In addition, the four DNRP agencies (WLRD, Parks, WTD, and SWD) share a single GIS server.

4.3.3 Staff

For purposes of this document, staff persons are counted in the department where they physically reside, regardless of where their salary is budgeted.

There are 72 GIS staff (+/- 3) and approximately 685 end-users (+/- 5%) in King County GIS. The largest numbers of staff reside at the GISC (17) and KCA (9), and the largest numbers of end-users are at DDES (150) and Transit (130). Large numbers of end users also reside in WLRD (80), KCA (70), REALS (50), and Roads (45).

Training of GIS staff and end-users takes place mostly through the KCGIS Center. GIS staff also tend to take courses from ESRI and attend seminars and conferences, depending on a given agency's budget situation. End users receive ad-hoc training from their GIS support staff either in lieu of or in addition to KCGIS Center training.

4.3.4 Budget: Current and future

GIS budgets have been no less subject to countywide cost saving measures than any other. Many of the low-use agencies do not have specific items in their agency budgets for GIS. Others, including DDES, rely on revenue from fees to help support the agency GIS operation. Overall, the picture is fairly dismal. Specific information on 2004 agency GIS budgets can be found in the 2004 GIS Operations and Maintenance document.

Most agencies expect no change in their GIS budgets in the next few years.

4.3.5 Software and Licenses

GIS licensing issues are discussed in more detail elsewhere in this document.

Arc 7.x: 31 licenses, 18 of which are administered by KCGIS Center on the server *WILDFIRE*. 9 others reside at KCA on their Sun machines.

Arc 3.x: 221 licenses. Every agency has at least 1 ArcView license.

Arc 8.x: 62 licenses. 19 are at GISC; 19 at WLRD (15 of those are currently unused).

GIS extensions: 76 licenses. This includes all ESRI extensions and versions.

SDE: DDES and KCGIS Center (enterprise)

Oracle: Transit and KCGIS Center (enterprise)

SQL Server: DDES, KCA and KCGIS Center (enterprise)

ArcIMS: DDES, WLRD, and KCGIS Center (enterprise)

Map Objects: DDES, KCA, and Transit

ERDAS Imagine: GISC, WLRD

Most agencies responded that they planned on obtaining additional ArcGIS licenses, either to augment existing ArcGIS 8.x licenses, or as upgrades to existing ArcView 3.x licenses.

4.3.6 Use of GIS Software

GIS use across the county falls into predictable lines. GIS staff use GIS every day, while users access GIS when they need it for their business functions. Most of the users fall into the "once a week or so" category, although there is a significant population of planners and appraisers (and others) who use it less. Another significant population of users, notably in DDES and Transit, use GIS every day because it is embedded in applications that they use for their routine business. There is also a nontrivial population of "power users," who, while they are not GIS professionals, nonetheless use GIS every day, are very competent, and keep informed of developments of GIS software.

End users and much of the GIS staff never touch Arc/Info 7.x. Those who do, tend to use it daily. ArcGIS 8.x use is a bit less narrowly-defined: GIS staff in all but four agencies (Budget, PubHealth, Sheriff, Council) have at least experimented with it, and it is used on a regular basis for analysis and mapping in DDES, GISC, WLRD, Roads, and Transit. No agency has given up ArcView or Arc/Info to use ArcGIS exclusively. In addition to the GIS staff, there are approximately 3 end-users who are also experimenting with ArcGIS.

ArcView 3.x is the most commonly used GIS software in the county. Nearly all of the GIS staff and virtually all of the end-users run ArcView on at least an occasional basis, usually more often. Those GIS staff who do not maintain GIS data – and some who do – use it on a daily basis, along with a significant portion of the users.

Use of extensions varies widely among agencies and types of user. The most commonly used extension is Spatial Analyst (3.x), reported in seven of the agencies. 3D Analyst, COGO, GRID and Network are also used, although less often and in fewer agencies. GIS staff make the most use of extensions, although users in WLRD, WTD and Transit occasionally access extensions.

4.3.7 Use of Enterprise Applications

Enterprise applications are those that are available and appropriate for everyone using GIS in King County. Description of enterprise applications can be found in the O&M Document.

Front-end applications:

- AVLib (ArcView extension): Heavy use by GIS staff in multiple departments; heavy use by users in multiple (but fewer) departments
- ParcelTools (ArcView extension): In general, less use than AVLib, but still occasional to heavy use by GIS staff and users
- iMAP and Parcel Viewer (internet ArcIMS applications): Widespread use in multiple departments by both GIS staff and users.

Back-End applications: None of the back-end applications are ever accessed by users; use listed below is by GIS staff only.

- Sitetool (data stewardship): Very low use, which is expected due to the nature of the application.
- Doctool (data documentation): Very low use; highly correlated with users of Sitetool.
- MaintRec (RECDNET editor): daily heavy use at KCA; not used otherwise.

- Keytool (editor for conflated coverages): Only one person in one department (KCA) admits to ever using Keytool, and then only occasionally.

4.3.8 Use of Non-Enterprise Applications:

There are three non-enterprise applications: Base2, developed and maintained by DDES; AVMaps, developed and maintained by Transit; and StreetTool, developed and maintained by the KCGIS Center. Each of these is used in a limited number of agencies. Of the three, Base2 is the most widely used, and DDES has indicated that it hopes to eventually migrate its functionality to the ArcGIS environment.

Nine agencies do at least some in-house development of applications. These range from small mapping utilities to multiple, cross-platform integrated applications. A variety of languages and platforms are used: AML, Avenue, MapObjects, ArcObjects are by far the most common.

4.3.9 Connecting to GIS and Non-GIS Data

All agencies connect to the central GIS server (*WILDFIRE*) on at least an occasional basis. Those with slower connections, or who routinely modify enterprise data for their own use tend to connect less often and download what they need. In addition, most agencies store department-level GIS data on their own servers and local machines.

There is a high correlation between agency GIS use and frequency of connection. All but one of the high- and mid-use agencies connect to the enterprise coverage library at /plibrary on a daily basis. Transit (high-use) connects once per week for automated download, and OEM (mid-use) never connects. None of the low-use agencies ever connect to /plibrary.

The correlation is less strong for connecting to the enterprise shapefile library at /plibrary2. All of the high-use agencies (except Transit, with an automated weekly download) access /plibrary2 daily. All of the mid-use agencies except OEM also access /plibrary2 daily; OEM downloads shapefiles quarterly. The low-use agencies present a more mixed picture: only Sheriff connects to /plibrary2 daily, two agencies (Council and SWD) connect weekly; and two (FMD and KCIA) connect rarely or never.

There is no correlation between use and access to SDE, as the only agencies that connect to SDE on more than an occasional basis are GISC, which uses it daily; and KCIA which connects occasionally through their single application.

In general, business data that connects to GIS data is housed in a RDBMS, usually Oracle or SQL Server. Most agencies that connect their business data to GIS data, or vice versa, do so using ad hoc joins. In addition, a number of agencies use programmatic joins within in-house applications. Transit and KCA use snapshots of business data to connect to local GIS data, and Transit has applications that rely on snapshots of GIS data to connect to business data.

4.3.10 Perceived Advantages and Disadvantages to ArcGIS

While the level of sophistication using ArcGIS varies widely among GIS staff, almost everyone has at least started ArcMap or ArcCatalog and looked at the interface. The two tables below list

perceived advantages and disadvantages of the ArcGIS environment (numbers in parentheses indicate number of responses, if greater than one).

Perceived Advantages of ArcGIS
Interface and tools:
Editing functions are better (3)
Nicer interface (2)
Improved data administration tools (3)
More sophisticated / better tools (3)
Moving away from the command line environment (2)
Many extensions are now built-in
Data
GDB (3)
Topology rules are promising (2)
Versioning (if it works)
Better integration of business and spatial data
Potentially better data sharing
Potentially better synch between coincident layers
More robust from database standpoint (vs. INFO)
Data storage in integer form
Better connectibility to external RDBMS
Relationship classes
Less complex data model than Arc/Info 7
Potentially easier data manipulation
Customization
More open standards – less proprietary environment (3)
Customizing is in-line with other Windows environment (2)
Will help end-users who are familiar with Access and but have trouble with ArcView data model
Other
Standard set-up
Will facilitate large data projects like *T*NET
Increased stability
Metadata creation

Perceived Disadvantages of ArcGIS
Migration issues
Learning curve / training issues (5)
Data conversion (3)
Lack of backward compatibility (3)
ESRI approach of "anything goes - fix it later" (consistent release of buggy / incomplete versions) (2)
Cost of licensing (2)
Document conversion

Perceived Disadvantages of ArcGIS
Lack of available documentation and ESRI history of software bugs exacerbates problems
Stability issues
Lack of awareness of limitations
Timing
Difficult programming language and lack of scripting environment precludes programmatic customizations by users
Still waiting for proof of promised functionality that has yet to be delivered – any migration assumes/requires that functionality
Confusing licensing
Data
Projection issues with shapefiles
Rule-based GIS may not be the appropriate path
SDE as single point of failure
Retooling
Gotchas and hidden pitfalls (unknowns) (2)
Can't convert AML
Retooling legacy applications
Can't customize automated data processing
Interface
One map per document limitation (3)
Over-empowering users
Manipulating tables is more difficult
Can't uncover functionality without customizing
Labeling
Printing problems

4.3.11 Is Migration Necessary?

No respondent answered "no" to this question. The most common answer to the question of "why is it necessary" was that the industry is headed toward the new technology and we don't want to get left behind. There was also a common feeling of inevitability. DDES and Transit respondents felt that ArcGIS will likely turn out to be cost effective in the long run.

4.3.12 Migration: Timelines for Agencies

Eight of seventeen agencies have already begun moving some or all of their GIS operation to ArcGIS; seven have not, one (KCIA) installed ArcGIS at the inception of their GIS program, and one (SWD) does not yet have enough of a GIS operation to have anything to migrate. Three agencies (DDES, Roads, and Transit) have or will have migration plans by midyear 2003.

Only one agency (DDES) has indicated an intention to migrate its GIS operation to ArcGIS before the enterprise migration. The majority of the rest (10) intend to migrate during, as a part of, or after the enterprise migration. Three agencies (FMD, OEM, Roads) have indicated that they will migrate when necessary, regardless of the status of the enterprise migration.

A common theme here is an unwillingness to be first to fully migrate. Many agencies are waiting for the enterprise migration; some to better coordinate their own migration, others to take advantage of the experiences of others.

4.3.13 Migration: Results from Early Adopters

Of the agencies who have begun migration, it is currently the GIS staff who are most using ArcGIS, and even then, that use is not exclusive. Staff generally revert back to more familiar/functional software (ArcView 3.x; Arc/Info) when encountering deadline pressures, or problems such as reduced software functionality and bugs.

Except for occasional use by a few power-users, no end users are currently using ArcGIS. Survey respondents are mixed on whether to convert users, and if so when. No agencies intend to migrate their users immediately; indeed, two agencies – DDES and WTD – have no plans to migrate end-users at all. Instead, they intend to develop other methods for users to access data without the overhead of ArcGIS. Transit intends to evaluate their situation later in 2003. The rest of the agencies intend to migrate their users after their GIS staff, allowing better support.

Reported ramp-up time for ArcGIS varies with user sophistication and desired functionality. Most agencies report that for their GIS staff, the time to get comfortable has been on the order of months; most feel that end users will have a more difficult time.

Agencies report that ArcGIS has in general helped their operation, even after initial hindrance; however, it is still only used when it offers an advantage over ArcView or command-line Arc/Info. One agency (GISC) reports that ArcGIS has been more of a hindrance due to the amount of time spent dealing with bugs and finding workarounds.

None of the agencies report that using ArcGIS has changed the way they do business in an overall context. However, for those agencies which produce quantities of maps, the single-map-per-document limitation has had an effect. Map production staff in WLRD and GISC find this limitation onerous, as many of their ArcView documents consist of multiple layouts – these documents will either have to be converted to multiple ArcMap documents, left in ArcView as legacy documents, or another solution will have to be found. DDES has solved the problem for their Zoning and Comprehensive Land Use Atlases by downloading and customizing ESRI's free Map Book developer sample.

4.3.14 Likes and Dislikes of ArcGIS

Early adopters were asked what they particularly liked and disliked about using the ArcGIS software. While there were quite a few comments on the favorable side, the gripes far outnumbered them. It would seem that this conflicts with the earlier statement that ArcGIS has in general helped agency operations. A possible explanation is that the "likes" appear to be much broader in scope ("easier editing"), while many of the "dislikes" revolved around very specific bugs and feature limitations ("sometimes unable to save files to the server "file is locked" even there's no way it could be"). However, a number of the "dislikes" are also of broad scope ("tends to spawn user problems").

"Likes" included nicer map output; faster, better access to different types of data; image handling; easier editing as opposed to command-line; and the open environment.

"Dislikes" included limitations to map output; the "one document, one map" limitation; lack of casual scripting; large amounts of bugs and the release of unfinished software versions; and a large number of specific technical problems dealing with map production in ArcMap.

The full list is detailed in Appendix C.

4.3.15 Perceived Effects of Enterprise Migration

Most agencies expect no to little effect of the enterprise migration upon their user base, especially if shapefiles are maintained. DDES is the exception in that they plan to replace their current user toolset with a totally new one. They hope that the adverse impacts on the users (short-term loss of productivity, need for training) will be outweighed by the better availability and uptime.

Most respondents (9) expect there to be little to no effect on their agency's business stemming from the enterprise migration. Some (4) expect the migration will allow faster and more efficient access to data. Others hope that it will allow better agency cross-coordination, data sharing, and better integration into and with the enterprise as a whole.

When asked if there were any special problems their agency may face as a result of the enterprise migration (either in its GIS or overall business), the most common response was training. Dealing with the relatively steep learning curve that ArcGIS offers presents an issue as training budgets are being increasingly tightened. Another concern is data: conversion of enterprise and local data to geodatabase format; access to that data by staff and end users; issues concerning Transit's *7*NET project; issues concerning connectivity between local RDBMS and the new GIS formats; and issues concerning the security of sensitive agency information. Finally, GISC has the somewhat unique challenge of maintaining enterprise operations during the migration.

4.3.16 Migration Challenges for Agencies

The learning curve and adapting to the new environment is perceived to be the biggest challenge to the agencies (7 respondents). Finding the training time and dollars to retool people to use the new software, applications, and tools will be an issue across the county. The timeline of the migration – deciding when to migrate and doing so in a timely manner – is another issue, especially as it relates to training. Other challenges that were mentioned are finding the money to migrate, and dealing with the conversion of data, applications, and maps. Finally, GISC expects a large decrease in productivity – they will spend hundreds, if not thousands, of hours of dealing with the software migration.

4.3.17 Migration Challenges to the Enterprise

Answers to this question were more varied than those to the previous. More than one respondent replied that they weren't sure on specifics, but that the migration would certainly be challenging. Responses and their frequency are listed below; numbers in parentheses indicate number of responses, if greater than one.

- Maintaining parallel systems (4)
- General data issues: conversion, access, reorganizing (4)
- Migrating end-users, supporting them, and making sure none are left behind (4)
- The implementation (3)
- Communication / coordination (3)
- Legacy / replacement apps (3)
- Agency support (3)
- Data conversion to geodatabase (2)
- When/whether to stop supporting AV3.x
- The learning curve and training
- Agreeing what to do
- Inertia
- Funding
- Ramping up non-GIS support staff

4.3.18 Migration of Data

Of the agencies that maintain in-house data, three have already started converting to geodatabase format, or intend to do so very soon. Three more intend to convert during or after the enterprise migration, and an additional three say that they are likely to convert their data, but no time soon. OEM is unlikely to convert their data until their third-party vendor migrates; KCIA maintains all of their GIS data in the enterprise SDE instance already, and Transit intends to only convert for maintenance purposes – user access will still be through shapefiles.

Seven of the agencies house either business data, or GIS data, or both in RDBMS. Most do not expect any effects of the enterprise migration upon their databases. KCA expects complications if they try to integrate the Assessor's SQL Server database with the GIS database; in addition, there are other issues with older business systems. REALS has legal limitations on accessing their Oracle business tables, so connections will be problematic. KCIA is just starting to deal with agency-wide RDBMS, and hopes to build on or integrate with existing SDE data.

4.3.19 The Enterprise Geodatabase Data Warehouse

The KCGIS Center is in the process of defining and implementing a SDE data warehouse using SQL Server. Respondents were asked for opinions.

A general feeling is that communication and documentation will be an essential component of implementation. In particular, users will need to be educated as to which data source to connect to, and why. There was additional concern that shapefiles be maintained, especially for users. One respondent who is familiar with both SQL Server and Oracle commented that SQL Server is a good platform for serving a lot of data to many users, and that Oracle is better for editing large datasets.

There was some concern over attaching to the new data warehouse – if it is to be deployed with SDE 8.3, then ArcView users will have to upgrade to ArcView 3.3 in order to connect. Other connection issues included network latency, and the possibility of having to build new user-interfaces to access the new warehouse.

The timeline does not seem to be important. No one expressed a great need to hurry, and when pressed for a date, responses ranged from six months to two years.

4.3.20 Migration of In-House Applications

No one except DDES and Transit has started or even really planned their own migration of in-house applications to ArcGIS format. DDES's Zoning and CPLU atlases are already maintained in ArcMap; their ArcView application Base2 is scheduled to be migrated by June; and their data maintenance tasks will be converted starting some time after June. Transit is in the process of converting all of their UNIX-based applications to NT, and expects to be finished in 2003. KCIA's two applications were implemented in ArcGIS, so there is no need to migrate.

4.3.21 Migration of Enterprise Applications

Responses to the question "What sorts of enterprise applications would you like to see?" fell along the lines of access to data and easy map production. Continued development/replacement of the existing ArcView extensions AVLib and ParcelTools topped the list, followed by continued development of the enterprise ArcIMS tools iMAP and Parcel Viewer.

Responses and their frequency are listed below; numbers in parentheses indicate number of responses, if greater than one.

In general:
Access to data (2)
Integration of imagery into existing and future applications (2)
lightweight browser based end-user solutions that don't require exorbitant cost of ArcMap licensed seat
keep current functionality available
improvement in metadata (quantity and quality rather than the app)
Integration of survey with assessments
Incident mapping
Web-based apps – mapping apps, they're getting better but are still clunky
Better quality maps
It would be nice if Base2 assets could be ported to a web-based interface
Standard graphic/display library, especially of countywide maps: bus routes, park systems, etc
Wireless/remote data entry and delivery of maps and data (ArcPad)
Specific suggestions:
Quick and easy map production with adherence to cartographic standards (5)
Parcel Tools replacement (5)
• better, more legible annotation this time
• on-the-fly overlays of other data and imagery
• make it portable to allow local data access for users in the field and remote facilities where bandwidth is limited.
AVLib replacement (5)
• add access to local information
• we need enterprise-wide mapping production and data access that can deal with shapes, GDB, in ArcView, Arc8 and MO environment, and is deployable against internal databases and data warehouses. Envisions a COM or DLL object.

• remove the views
Continued development of iMAP / ParcelViewer (3)
• include a map with iMAP D/D report
• specialized smaller apps (datasets) for specific functions for use in the field
Census data viewer (hook to property)
Print quasi-official Assessor maps
Query application – maybe web-based. Display the 50 most-looked at data items and make your own query.
Real-time updates of cadastral and other data
Doctool replacement
Direct posting of shapefiles
Enterprise data conversion from non-GIS or external data sources (table conversion, etc)
Streets application
Metadata tools

4.3.22 Support from the KCGIS Center

Most agencies will rely to some degree on the KCGIS Center for help migrating, with training the biggest need with twelve responses. Eight agencies desire general help migrating, three desire help with data conversion, and four desire help with application conversion.

On a more general front, communication is perceived as one of the most important aspects of KCGIS Center efforts. KCGIS Center should coordinate the sharing of knowledge / experiences among early and late adopters; offer training and less-structured information dissemination sessions in a timely manner; communicate changes early; provide documentation on both a technical and user (how-to) level; and share information at both the Technical Committee and User Group levels.

Agencies expect the KCGIS Center to offer support in other areas as well. They should offer desktop support in the form of available KCGIS Center staff persons to answer quick questions from agency staff. The KCGIS Center should take the lead role in migration – preferably make the mistakes first so that others can avoid pitfalls. Also viewed as important are technical collaboration, especially with respect to implementing topology.

4.3.23 Other Comments

At the end of each interview, respondents were given the opportunity to add additional comments. Most of these comments have been incorporated into the general discussion both above and in the Themes and Conclusions sections below.

4.4. Themes

A number of concepts cropped up during the course of the interviews. The themes of training, communication, cost, phased approach, continued support for shapefiles, and user migration will be discussed in the sections below. Each of these will be important to the planning and

implementation of a successful software migration, and will be incorporated into the plan that is adopted.

It should be noted that since a year or more will pass between the agency interviews and the beginning of the implementation of the software migration, it is expected that there will be some changes to not only the quantitative answers, but possibly to GIS business practices as well. It would be wise to perform a review before embarking upon implementation.

4.4.1 Migrating the Users

It quickly became very clear that Technical Committee members and/or their GIS staff are unwilling to migrate their users immediately. The general feeling is that users want a easy, intuitive interface that will help them get their job done without the overhead of having to learn a complicated software. Most respondents felt that without some sort of customized user interface, the steep learning curve and complex native interface of the ArcGIS software will make it too difficult for the majority of users to use effectively.

Agencies are grappling with the question of whether to even migrate their users, and if so, which ones and when. DDES, Transit, and WTD are exploring the options of not even offering ArcGIS to their casual users, but rather implementing data access and analysis solutions in other ways, most notably ArcIMS.

Another point on user migration is that it is not a good idea to offer casual users multiple options for data access. Rather, access should be transparent with respect to actual data location. Most users don't know the difference between a shapefile library on a local server, and an SDE instance on the enterprise server; they don't care, and they should not have to. Making the data source transparent makes them more efficient, and reduces support load on GIS staff.

A last issue with migrating users is timing. If GIS staff have the opportunity to become fully up to speed with the software before users migrate, they can provide better support within their own agencies.

4.4.2 Support for Shapefiles

Currently, a common user set-up is ArcView 3.x accessing shapefiles, either from the enterprise data warehouse at /plibrary2 or from local servers or machines. For this reason, support for shapefiles is intimately tied to the migration of the users.

While it is possible to upgrade ArcView to be able to access SDE, it is widely assumed that users will still desire or need access to shapefiles even after the SQL Server-driven SDE enterprise data warehouse is in place. Since users are unlikely to migrate without either a pull (better software functionality), or a push (discontinued support of software and/or data formats), one or the other must take place before users migrate.

Support for shapefiles must be maintained until all (or a predetermined, agreed upon, high percentage) users are migrated.

4.4.3 Phased Migration

The notion that the software migration will have a phased approach is a widely held assumption among Technical Committee members and their GIS staff. In fact, this is already a reality, as a number of agencies have already started their own migrations. The complexity of the enterprise migration and the needs of the users – specifically regarding the need to maintain shapefiles for a indefinite period of time – will almost certainly force a phased migration. The common assumption is that GIS staff will migrate first, followed by data and applications, then finally the users.

4.4.4 Training

ArcGIS has a steep learning curve, especially for end-users, so it is not a surprise that the most-mentioned challenges to agencies revolved around training issues. In an environment of tight budgets, cutbacks in funding for user and staff training are common. ESRI training is expensive, and for some agencies with very tight budgets and/or many end users, even training through the KCGIS Center may be cost-prohibitive.

Informal (non-classroom) training options should be explored. A few respondents mentioned the "brown-bag" iMAP lectures as a template, and a few others mentioned that it would be nice if training could come to their location and be more tailored for their specific needs, instead of their users going to a "training room" and learning from generic data and connection methods.

Training is discussed in Section 9.

4.4.5 Communication

Communication quickly came to the forefront as a major issue. Communication/coordination issues ranked high on the list of "biggest challenges to the enterprise." Communication was brought up as an essential element in the implementation of the geodatabase data warehouse, and was specifically brought up a number of times in other contexts as an area where the KCGIS Center should concentrate its efforts. When specifically asked about support needed from the KCGIS Center, communication was generally mentioned the most often.

Agencies feel that the KCGIS Center should take the lead in coordinating migrating agencies; should make sure that the plan, its implementation, and its status are well-publicized; should provide both technical and user documentation; and most importantly, make sure that information is presented in a timely manner.

Communication is discussed in Section 10.

4.4.6 Cost

Even if agency budgets weren't tight, the cost associated with migrating to ArcGIS would be an issue. ArcGIS licenses are substantially more expensive than ArcView 3.x, and the cost of upgrading the entire user base to ArcGIS makes many of the Technical Committee members shudder. In addition, unlike MapObjects, which only requires a single MapObjects license to deploy to many desktops, ArcObjects applications cannot be accessed without an ArcMap license for each user. While the argument can be made that this is the same way that ArcView 3.x works, the issue is the cost of the license.

Unless ESRI comes through on their promise to reevaluate their ArcObjects licensing scheme, it will be necessary to at least look into alternate methods of providing users with the tools they need without implementing ArcGIS on every user desktop.

4.5. Conclusions:

1. Communication is a key element of a successful software migration.

2. Training needs to be timely, cost-effective, well-planned, and customized.

3. Issues involving the migration of users will necessitate a phased approach, the retention of shapefiles as a data source for a certain amount of time, and a careful assessment of actual use and the possibility of non-ArcGIS solutions on user desktops.

4. Since business and technology needs may have changed since the agency survey was completed, it is recommended that agencies perform a business needs analysis (of scope to be determined) before embarking on migration.

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5 Agency Migration

5.1. Overall goals

- Discontinue the need for and use of coverages as the primary source for GIS data.
- Maintain access to shapefiles for a sufficient period of time to ensure that users can migrate according to their business needs.
- Minimize cost.
- Minimize disruption to users
- Ensure that business needs continue to be met during and after the migration.
- Create a maintenance environment that is equal to or an improvement on the existing maintenance environment.
- Streamline data maintenance procedures for shared data layers
- Investigate opportunities to leverage GIS to existing business RDBMS.

5.2. Defining agency business needs

As was made clear in the survey, the sixteen agencies that use GIS at King County vary widely in their levels of staffing, funding, GIS needs, and sophistication. A data maintenance and access solution that works for one agency may not work for all or even any of the others. Therefore, we cannot approach migration at the agency level as a "cookbook" type of exercise.

It is imperative that agencies determine their business needs for GIS, or at the very least, whether their business needs have or will change with the advent of ArcGIS. The evaluation of business needs has been performed in the past, if only within the context of setting up the initial system in 1994. But the radical change of technology necessitates that the process be repeated.

While the survey that is discussed in Section 3 is a necessary and important element to the migration plan, it cannot be used in place of an evaluation of agency GIS business needs. In order for the software migration to be successful, agencies will need to conduct an internal assessment of their use and need for ArcGIS. The assessment can either be performed internally on an agency-by-agency basis, or it can be a more formalized shared experience that is coordinated by the Software Migration Workgroup or the Technical Committee.

At the very least, the internal assessment should contain the following:

- Statement of agency business need for GIS;
- License audit for current use of Arc/Info, ArcView 3.x and extensions;

- Definition of the set of GIS users in the agency and how they use GIS to do their jobs (as opposed to how they "think" they do their jobs);
- Determining the nature of use of coverages and shapefiles;
- Determine issues that are barriers, impediments or merely concerns to a successful software migration at that particular agency;
- Expected timeline for the various phases of migration, including a statement of accuracy.

5.3. Issues facing agencies

It is not the intent of this document to offer solutions for all of the issues that are outlined below. Rather, these are the topics that will need to be dealt with by the Software Migration Workgroup and the Technical Committee as the software migration progresses. One approach is for the Software Migration Workgroup to create an individualized migration plan for each agency. The agency can then determine on its own how and when to implement, and what type and degree of assistance is needed from the KCGIS Center and possibly Software Migration Workgroup.

In a number of cases below, additional information, solutions or recommendations are listed in other parts of this document – these are noted where appropriate.

5.3.1 Training issues

Training is discussed in detail in Section 9.

- Timing and flexibility of training schedule: Agencies are concerned that they will be forced to take core concept training (e.g., Geodatabase Design) at inopportune times – either too far in advance of their migration, or worse, after the fact.
- Location: ESRI training in core concepts is not offered on a reliable basis in Seattle. Courses can be cancelled due to low turnout, which forces students to look elsewhere – generally out of state – in a time of countywide travel restrictions.
- Cost: Training is expensive, and there are agencies that will not be able to budget what they need to get their GIS staff, much less their users, ready for migration.
- Generic nature of ESRI training: ESRI courses must meet a wide variety of student needs, and therefore tend to offer generic curriculums. While students can and will learn the basics and core functionality of ArcGIS software, they will not be equipped with the knowledge they need to apply their learning to enterprise and agency-specific scenarios. In addition, some of the training topics that are offered are either not workable solutions or are too simplistic for King County's distributed/integrated system.

5.3.2 Data modeling and design issues

Data migration options are discussed in Section 7.

- Timing: Data modeling and design must come first – that is, it should precede application development. While it is highly likely that there will be tweaks to the data model after application development begins, developers will need a good understanding of the data model before beginning the development of enterprise and agency applications.

- Integration of business and GIS data: Now that both GIS data and business data are moving into relational database formats, there are new opportunities available for integration. This is a good time to look for ways to streamline individual agency business processes using GIS, and conversely, to better integrate GIS data into existing non-spatial business functions.

- Risks of integrating data: There is concern over the possibility that integrating GIS and business data can be a detriment to both. Risks will need to be carefully assessed and contingency plans created.

- SDE access: Many of the smaller agencies lack resources (personnel, technical, political, monetary) to set up their own SDE instances for editing data, and will need to rely on the enterprise production database. Database access, data design, and maintenance processes are all issues that will need to be dealt with on the enterprise server so that these agencies can maintain their data in an efficient manner.

- SDE backup and recovery: It will be important that SDE is set up and implemented so that backup and recovery efforts do not interfere with business processes.

- Optimizing ArcGIS capabilities for cross-agency maintenance: Dependencies between data layers that are maintained by different agencies will require a technical solution that currently does not exist with "out-of-the-box" ArcGIS. Specifically, topology rules and relationships can only be established for data layers that exist in the same dataset. This means that the cadastral base and all of its derivative layers must exist in the same dataset as all of the districting layers, many of the planning layers, and many of the street layers. If this sort of structure is put into place, it will require agencies to coordinate data maintenance efforts to a degree and scale not currently in place.

- Ensuring data integrity and security: A big challenge will be setting in place appropriate quality assurance (QA) procedures. Existing QA procedures work well for the existing processes, and most of these can and should be migrated. However it will also be necessary to determine appropriate new QA procedures that are specific to the geodatabase and the new data design. Agencies will need to differentiate between business and technical processes to come up with a set of QA procedures that meet the needs of all agencies. There may also be additional agency-specific procedures that will need to be put in place.

- Detecting and rectifying failures in the data design: Data modeling for ArcGIS and the geodatabase is radically different than the existing coverage environment, and a large concern is the possibility that we will not have the training and/or resources to recognize failures when they occur. Resulting corruptions in the data could go unnoticed for potentially long periods of time, or failures could propagate unnoticed through part or all of the rest of the system. While agencies understand and acknowledge that there will be challenges to the data design and implementation, it is the unknown and unknowable factors that are a cause

for concern, as it is these that have historically caused the most major disruptions to business processes.

- Addressing: Addressing is already a major issue, and will continue to be one in the new environment. Currently there are multiple countywide address tables, with different designs and maintained by different agencies using different applications. While there is agreement on the need for a single, integrated addressing system, the question is how to implement it and determining the most logical entities to maintain it. Should the format be tabular or geospatial? Should addresses be represented by ranges or points? Or should there be a mix of all?

- Data modeling with ESRI: If we are to bring in ESRI, it must be early in the data modeling phase. Past experience has shown that it will also be important that the effort be collaborative instead of one or the other side making suggestions.

5.3.3 Data conversion issues

- Timelines: How can we determine how long migration will take so that we can set accurate and reasonable timelines?

- Coordination of data conversion: Related data will need to be migrated at the same time. Identifying existing and desired relationships will be necessary before data migration begins.

- Pilot Process: It will be necessary to test any design and process before putting it into full implementation.

- Annotation: Some agencies hold data in annotation layers, which include text, lines, and symbols. ArcGIS and the geodatabase are perceived as being unfriendly toward the conversion and maintenance of annotation. This issue is of critical importance to KCA, which maintains the cadastral database.

- Metadata: The uneven quality of metadata for data layers residing in /plibrary is a long-standing issue. While agencies recognize the need for comprehensive metadata and certainly have the desire to remedy those instances of less-than-complete entries, most have had difficulty allocating the time needed to do so. Agencies and the KCGIS Center will need to put in the time and effort to get the metadata up to the standard stated in the Best Practices document.

5.3.4 Maintenance issues

- "Crack and Split" issue: When fundamental data layers are set up as the basis of a geodatabase, the addition of topological relationships from users who wish to "attach" their business data results in a cracking and splitting impact to a potentially large portion of the underlying data layer. Maintainers who are tracking changes to the underlying data layer for nightly processing activities will occasionally and unexpectedly be faced with identification of most if not all features showing as changed. In some scenarios, tracking changed features to focus review efforts could result in a undesirably large list for manual review.

- Single feature dataset: Topology rules and relationships can only be established for data layers that exist in the same dataset. This is a major issue. If we were to implement the production geodatabase using the relationships that make the most sense from a data design standpoint, all of the core layers (cadastral, transportation, planning, districting) would reside in the same dataset. Aside from the fact that the dataset would be unreasonably large, implementing access for the different steward agencies is perceived to be a nearly insurmountable task.

- No degradation to the maintenance environment: The maintenance environment must be as good as or better than the existing environment. This may appear to be an obvious statement, and one already rectified, but most of the agency representatives have had enough experience with ArcGIS to be able to easily imagine numerous ways that the new maintenance environment could be inferior. Speed/response time, redraw, user interface, tool accessibility and functionality, data assurance, and application stability have all been mentioned.

- Ensuring data availability through the migration process: Agencies will complete their migrations at different times, whether they implement their own SDE instances, or use the enterprise production geodatabase. All agencies must have access to usable data at all times. This will likely require the provision for posting of alternate data formats (such as geodatabase, personal geodatabase, or possibly even shapefiles) on either a temporary or permanent basis.

- Coverage obsolescence: Once a given agency has fully migrated, it will no longer be maintaining data in coverage format. At some point, coverages will be considered "obsolete." There needs to be a timeline for this process, or at least a listing of the critical steps and impacts.

5.3.5 Use issues

- Phasing out coverages: It will be necessary to determine who uses coverages for analysis and map-making (as opposed to editing data in coverage format). This will have a major impact on how the coverage library is maintained during the migration. If few or no individuals are using warehouse coverages for analysis and map-making, we can implement relatively simple local work-arounds; however, if coverage use is widespread, the problem becomes much more complex and will require a more formal solution. See Section 7.2.2 for discussion about migration impacts on coverages.

- Dealing with distributed resources / infrastructure: How will agencies that have no internal SDE support be accommodated so that they can use SDE and the geodatabase and leverage it for accomplishing their business needs? These are agencies that have no hope or intention to implement SDE in their own agencies due to lack of technical, political, monetary, or other resources. See Section 5.3.2 for information on the enterprise production geodatabase.

- ArcView 3.x users: Dealing with the large and diverse group of ArcView users in the county is a very large issue. How do we identify them? How do we determine what technical solution will best meet their needs then migrate them in the most efficient way? Do they need to migrate at all? How and when should they get trained, and how can we mitigate the cost?

At what point do we consider ArcView 3.x users migrated? See Section 9.1 for information on categorizing users.

5.3.6 Other issues

- Coordination: How can we make sure that the agencies act in a coordinated fashion to make the best use of acquired knowledge and experience, reduce redundancy, reduce cost, and ensure that no agency gets left behind?

- Surprise issues: Everyone, but most especially the agencies, anticipates unknown and unpleasant surprises both during and after the migration. While there is no real way to know what form these unpleasantries will take, it would be nice if we could plan to mitigate and deal with them.

- Impacts of integration: GIS is currently a very distributed operation in King County. Migrating to geodatabase format will necessitate some, and possibly a large, degree of integration of maintenance processes. We need to make sure that impacts of this integration are understood.

- External layers: Data layers that the county receives from external agencies are not altered except for conversion to coverage and shapefile format, and some naming changes to fit our convention. What steps (if any) will need to be taken to ensure that all agencies have access to external data during the migration?

6 Enterprise Migration

6.1. Overall Goals

- Decouple the data warehouse from the production area in order to optimize both. Production databases and data warehouses require significantly different architecture to operate optimally, which is why separation of these types of databases has become an industry standard.

- Discontinue the use of coverages as the primary source for enterprise GIS data, and in its place, implement an enterprise geodatabase using SDE running on Microsoft SQL Server.

- Discontinue the use of the obsolete coverage/keyfile system to create and maintain enterprise data.

- Maintain access to enterprise shapefiles for a sufficient period of time to ensure that users can migrate according to their business needs.

6.2. Enterprise Framework

6.2.1 Enterprise servers and hardware

6.2.1.1 Current configuration

The KCGIS Center operates several UNIX and Windows servers. These servers support a number of tasks both for all GIS users in the county and specifically for KCGIS Center staff, and include providing access to 1800GB of enterprise data storage space (*WILDFIRE* and *GISDW*), managing enterprise software licenses (*ORCA*), and delivering Internet mapping services (*HERCULES*). All servers are accessible via the county LAN/WAN. Details for individual servers are provided below. All systems reside in the King Street Center except where noted.

WILDFIRE – Alpha Server ES40, Digital UNIX 5.0a. *WILDFIRE* is the primary data server for enterprise GIS data. *WILDFIRE* also runs the licenses for ARC/INFO 7.x and the applications written for that software. Those applications support the core of the KCGIS Spatial Data Warehouse, and include applications for data creation and management, metadata input and output, RECDNET (cadastral base framework) editing and integration, parcel layer extraction, and coverage to shapefile conversion. *WILDFIRE* also runs RDBMS (Oracle) and ArcSDE instances.

There are several mount points for *WILDFIRE*, each with a specific purpose as shown in the following chart.

Unix mount point	Windows share	Use of storage location	Permissions
/plibrary	/plibrary	Coverages	Read-only
/maint	/maint	Data development	Read/write GIS site
/projects	/projects	Active projects	Read/write defined by owner

/scratch	/scratch	Temporary work	Read/write defined by owner, cleared weekly
/plibrary2	/plibrary2	Shapefiles and remotely sensed images	Read-only

ORCA – Compaq 8000, Microsoft NT 4. *ORCA* acts as a central server for the KCGIS Center. It is the primary license server for ESRI products (except those on *WILDFIRE*). *ORCA* hosts a network install of ArcView 3.x that is used by WTD, and it provides a large file system used extensively by the KCGIS Center for administrative files and all forms of project components (including ArcView or ArcGIS projects, data, and documentation).

HERCULES – www5.metrokc.gov, Compaq Proliant 7000, Windows 2000 Server. This machine resides in the Key Tower in King County's enterprise server computer room. It is in the KCWWW domain, which puts it in the "DMZ" between one firewall that separates it from the Internet and a second firewall that separates it from the rest of the KC WAN. *HERCULES* plays the web server role in the distributed architecture of the KCGIS Center's ArcIMS deployment. Currently the software installed on the server that is actively used includes the OS (Windows 2000 Server), Web Server (IIS 5), Servlet Exec (a Java servlet engine), and the Oracle ODBC and SQL Server drivers.

GISDW – KCGIS Spatial Data Warehouse Server – Microsoft Windows 2000 Advanced Server. *GISDW* is a virtual server comprised of a two-node cluster system configured with 2 RAID arrays, with future expansion for 2 additional RAID systems. The two cluster nodes are Dell PowerEdge 2650 servers named *DWGIS1* and *DWGIS2*. These servers consist of dual 2.4 GHz/512 Cache Xeon processors, 6 GB RAM, and two 18 GB mirrored drives which contain the server operating system. The database array is a single Dell Powervault 220S SCSI RAID array with 2-18 GB SCSI quorum drives and 9-35 GB drives for data. A second Dell PowerVault 220S array, consisting of 13-73 GB SCSI drives, provides capacity to house the KCGIS Spatial Data Warehouse digital imagery libraries. *GISDW* is configured with SQL Server 2000, ArcGIS 8.x and ArcSDE for SQL. The cluster system provides processing redundancy, fail over protection, and load balancing with added RAID systems. This system is now functioning as the primary data source for ArcIMS based applications such as iMAP and the Parcel Viewer. The new data warehouse will support the migration of King County's GIS application and analysis environment to the ESRI ArcGIS 8 product by providing the backend database engine needed in ESRI's new software architecture.

GISNAS1 – KCGIS Center NAS – Quantum SNAP 4100 server, with 400 GB disk system. This system houses KCGIS Center staff user home directories, administrative files and software media files from *ORCA*. This system will support file space for new projects.

GISNAS2 – KCGIS Center NAS – Quantum SNAP 12000 server, with 960 GB disk system. This system was acquired in 2003 to provide space to process new digital imagery being developed as a result of the ESA/SAO project.

KCGIS-EOC - EOC NAS – Quantum SNAP 2200 server, with 160 GB disk system. This system is installed at the Emergency Operations Center (EOC) for locally used shapefiles. This small desktop system is automatically updated from the King Street Center using Quantum Server-to-

Server software. This configuration will provide regularly scheduled updates of shapefiles to the EOC without requiring user intervention, and support EOC requirements to operate in standalone mode during emergencies..

MAPPER1 and *MAPPER2* - Dell PowerEdge 2650 with one 2.4 Ghz Xeon CPU, 1 GB RAM, and mirrored 36 gb hard drives (RAID 1), Windows 2000 Server. These two machines were purchased in 2003 to replace *KCGIS-SS1* and *KCGIS-SS2* as support for the distributed architecture of the KCGIS Center's ArcIMS deployment. *MAPPER2* serves as a "spatial server" to ArcIMS, which means that it receives requests from the "application server" component, connects to the data source (GISSQLDW, SQL Server 2000) and produces a response of either a map image or a stream of data in XML format. *MAPPER1* also serves as a "spatial server" to ArcIMS, as well as functioning as the "application server", which means it is the machine where most ArcIMS administration takes place.

WEBTEST – Master Computer, Windows 2000 Server. *WEBTEST* serves as the intranet web server for the KCGIS Center and as a development server for ArcIMS applications. This machine runs its own installation of ArcIMS and Servlet Exec. In addition to the development versions of iMAP and Parcel Viewer, there are a number of intranet only ArcIMS applications served from this machine.

KCGIS-SS1 and *KCGIS-SS2* - These two machines currently serve as the development environment supporting the distributed architecture of the KCGIS Center's ArcIMS deployment. *KCGIS-SS1* serves as a "spatial server" to the development instance of ArcIMS running on *WEBTEST*. *KCGIS-SS2* also serves as a "spatial server" to ArcIMS, as well as functioning as the "application server" for the development version of ArcIMS.

KCGIS-SQLDEV – Dell dual-processor (1.266 GHz), 1GB RAM; 9+9+85 GB hard drive on three partitions. Microsoft Windows 2000. Purchased in 2002, *KCGIS-SQLDEV* is a test server for SQL Server implementation.

GISPROD – This machine was purchased in Fall 2003, and will ultimately replace *WILDFIRE*. It consists of a Dell PowerEdge 6650 server powered with four 2.8Ghz/2MB cache Pentium Xeon processors, 8GB RAM, and two mirrored 36GB hard disks for the Windows 2003 Enterprise Server operating system. Attached to the server are Dell PowerVault 220S RAID arrays. Each RAID array contains fourteen 146GB hard disks. The RAID arrays is configured to operate in RAID 5 mode with at least one hot spare hard disk in each array.

GISIMAGE – Dell PowerEdge 1650 Server, Dell PowerVault 220S SCSI Drive Array, Windows 2003 Server. This server will be acquired to allow for processing of ESA/SAO digital imagery.

6.2.1.2 Future hardware acquisitions

HERCULES replacement – *HERCULES* is scheduled to be replaced in the second half of 2004.

6.2.1.3 Meeting the needs of the software migration and beyond

GISDW and *GISPROD* comprise the core of the enterprise data server system. They are expected to have useful lifetimes extending to 2007 and 2008, respectively. As each of these servers are brand new, and are expandable in both CPU and drive space, it is expected that they will more

than adequately meet the needs of the county's enterprise GIS until their planned replacement dates.

The functionality of the current enterprise server, *WILDFIRE*, will eventually be replaced by *DWGIS* and the new production server. It is expected that *WILDFIRE* will be able to handle coverage production work and Oracle needs at current levels until those needs are discontinued.

6.2.1.4 Application servers

Application servers offer a way to allow multiple users to access software without having local installations on their machines. This is particularly desirable in instances where budgets are tight, there are very many users, and/or local software installations are very expensive. Since processing takes place on the server, the user does not need a local installation of ArcGIS, and can therefore get away with a lower-powered (cheaper) PC.

It may be desirable to look into an application server as a means to reduce the number of Arc/Info or ArcView 8.x installations by managing some or all licensing and software management from a central location.

The server *ORCA* can be upgraded to operate as an application server running either Windows Terminal Server, or Citrix Server. In the case of Terminal Server, users would log in to *ORCA*, much as they currently do using Exceed to log in to *WILDFIRE* to access Arc/Info 7.x. Also like Exceed, they would see a desktop, but would have only limited customization options. Using Citrix, the user would launch the ArcGIS application from a desktop icon, whereupon it would appear as if ArcGIS were a local installation, but instead would be processing on the server.

Each has its advantages and disadvantages. Citrix has a more efficient protocol and allows the user more customization options, but it is much more expensive, and is really geared toward serving multiple applications. Windows Terminal Server incorporates nearly all the functionality of Citrix, and is cheaper, but offers the user fewer customization options.

Further investigation is warranted, at least to determine if an application server can be effectively installed and utilized.

6.2.2 Desktop Hardware

ESRI recommends the following desktop setup for installation and use of Arc/Info, ArcEditor, and ArcView. Anecdotal reports suggest that it is wise to run ArcGIS on the biggest, fastest machine affordable. It should be noted that disk space required varies with the installation options selected; for example, installing only ArcGIS Desktop requires about 500 MB of disk space, while a developer's setup (Desktop, Workstation, and the Developer Tools) requires over a gigabyte, depending on options selected.

Supported Windows OS	NT 4.0/SP6a, 2000, XP
CPU: minimum	450 MHz
CPU: recommended	650 MHz
Processor	Pentium or higher
RAM: minimum	128 MB
RAM: recommended	256 MB

Swap space	300 MB minimum
Disk space	695 MB (NTFS) + 50 install space
Browser	Internet Explorer 5.0 or greater
Also recommended:	• True color monitor with 16MB video card • Fast NTFS hard drive is strongly recommended

For the most part GIS staff in the county are using NT machines or higher; however, there is a significant portion of users running Windows 98. If these users are to be migrated to ArcGIS, their machines will need to be upgraded. Agencies should take this potential cost into account when upgrading users.

6.2.3 Front-End software

6.2.3.1 Arc/Info 7.x

Currently, coverage format is required for posting enterprise layers. Therefore, enterprise layers are either edited in Arc/Info 7.x, or converted to coverage format before posting. A number of agencies rely on in-house AMLs for processing and, to a lesser extent, mapmaking tasks.

There are few critical activities that can only be performed with Arc/Info 7.x. The most obvious and serious of these is the ability to edit coverages. Stewards will be unable to migrate to the ArcGIS software without first migrating their data to geodatabase or personal geodatabase format.

There are other critical activities can be performed with ArcGIS, but are more efficient, stable, or error-free on Arc/Info 7.x. These include viewing nodes and vertices, speed of redraw, and certain geoprocessing tasks (such as clipping) that are not yet fully natively incorporated into the ArcGIS platform. Also of concern is the snapping environment, which does not seem to be as robust, accessible, or intuitive as that of Arc/Info 7.x. Finally, while the annotation tools have improved in later versions of ArcGIS, working with annotation can still be difficult and problematic.

Until the cadastral geodatabase is implemented, tested, and accepted as the primary data format for parcel use, KCA will continue to use Arc/Info and the MaintRec editor for cadastral updates to RECDNET. Arc/Info 7.2.1 is the only 7.x version still in a “Support” phase (i.e., not retired), and is slated to retire when ArcGIS version 9.0 ships, sometime in 2004 (see Section 2 for an overview of ESRI technology and lifecycle support).

The enterprise license of Arc/Info on *WILDFIRE* is version 7.1.2, which is already retired. However, the possibility of stewards needing support beyond what can be provided by knowledgeable King County staff and ESRI staff at Olympia is slim.

Migration of specific enterprise AML applications will be discussed in Section 6.2.6.

6.2.3.2 ArcView 3.x

ArcView 3.x is widely used across the county, for everything from simple shape display to complex analysis and map design. In addition, many agencies rely on Avenue scripts and standard documents to perform day-to-day tasks.

A well-thought-out and phased migration from ArcView 3.x will be especially important and necessary to mitigate problems associated with the transition. Agencies will need time to prioritize and assess their Avenue applications and ArcView standard projects, and then determine the best course of action to migrate those applications that they deem of primary importance to their business functions.

It is expected that the migration of ArcView 3.x users will take some time. To that end, the enterprise shapefile library must be maintained for some time after the coverage library has been discontinued, and the KCGIS Center must provide support for ArcView and enterprise ArcView 3.x applications until it is determined that such support is no longer needed.

Specific enterprise applications will be discussed in Section 6.2.6.

6.2.3.3 ArcGIS

KCGIS Center currently maintains a number of ArcGIS licenses hosted on *ORCA* for use by its Client Services group. KCGIS Center staff have been using ArcGIS on an increasing basis since version 8.1, although no one uses it exclusively. A number of users in other departments also access the license server on *ORCA*.

The current version of ArcGIS is 8.3, and ESRI plans to release version 9.0 in mid 2004. Version 9.0 holds the promise of data modeling, better integration of geoprocessing, better annotation tools, and scripting. Otherwise, according to ESRI, the core functionality of 8.3 will remain undisturbed.

It is recommended that King County standardize on one version, and that version should be 8.3. Version 8.3 offers the topology and geodatabase tools that are needed in order to create, test, and begin maintenance of the cadastral geodatabase. Version 9.0 will likely be released before the county's migration is fully implemented, but for a number of reasons, it is recommended that we not immediately upgrade. ESRI has a history of releasing buggy and incomplete "dot zero" versions. While it is acknowledged that they have pushed back the release date of 9.0 to keep this release from being rushed, there is no guarantee that this release will be of enough benefit to the enterprise to warrant a second, or asynchronous upgrade. Second, the 9.0 upgrade is more of a follow-up than a new and different version. Skipping this version should have little or no effect on the majority of users. According to ESRI, version 9.1 should come out quickly after 9.0, and at that time, we should re-evaluate whether to move to that version.

KCGIS Center should publish a statement that includes the version(s) of ArcGIS that are currently being supported, which version is being used to develop enterprise applications.

6.2.3.4 Unavoidable and significant changes to general workflow

The drastic change in architecture from Arc/Info 7.x and ArcView 3.x to ArcGIS will have an impact on how users perform common functions.

One obvious example is that most editing functions in ArcMap are significantly easier and more straightforward than their counterparts in command-line Arc/Info. This could, for instance, do away with the need to build a complex suite of editing applications to replace the MaintRec editor. However, stewards will be responsible for learning a more sophisticated user interface.

They will have more opportunities for user error, and will be expected to be able to do their own top-level trouble-shooting.

Other changes to workflow are inevitable. For example, the current integration cycle will eventually be abandoned, and users and stewards will need a period of time to adjust to the geodatabase. This means that a gradual conversion and parallel systems will be necessary, at least for some period of time.

Once data layers are migrated into the geodatabase, those layers can no longer be edited in coverage format. This problem is discussed in Section 7.2.2.

6.2.4 RDBMS

The original goal was to have both the data warehouse and the production databases reside in Oracle on *WILDFIRE*. However, the problems that were encountered implementing the test production instance in 2002, the fact that the Oracle data warehouse was largely unused due in part to connectivity issues, and the decision to move the data warehouse onto the Windows platform necessitated a change of plans.

The ultimate goal now is for the entire enterprise RDBMS to move off the Unix/Oracle platform and onto Windows/SQL Server, for a number of reasons:

- Windows servers and SQL Server are cheaper to purchase, upgrade, and maintain than their UNIX and Oracle counterparts
- We have better in-house support for Windows servers and SQL Server
- SQL Server databases are easier to administer and troubleshoot, less prone to connectivity problems with the rest of the Windows world, and have the edge over Oracle when it comes to serving up large amounts of read-only data.

While Oracle is better than SQL Server at processing large amounts of transaction editing, and is perceived as a slightly better platform for editing of spatial data in versioned SDE databases, our past experience with such has been less than optimal. The postponement of the implementation of the versioned Oracle SDE production database will allow us to more fully test the option of implementing SQL Server, and thus keeping our production and data warehouse databases as parallel as possible.

6.2.4.1 SQL Server

The KCGIS Center has two enterprise licenses of SQL Server 2000, one each installed on *KCGIS-SQLDEV* and *DWGIS*. The instance on *KCGIS-SQLDEV* is for testing and development, while the instance on *DWGIS* supports the new data warehouse.

6.2.4.2 Oracle

Two Oracle database instances are licensed. A standard edition is licensed for an unlimited number of client connections and two host CPUs, and an enterprise edition is currently licensed for 15 named users and includes the Oracle Spatial data types option. The original plan was to use the standard edition for the read-only data warehouse, and the enterprise edition to support

data editing. While the data warehouse was implemented using ArcSDE, it was not used except for the enterprise ArcIMS applications. In addition, the problems encountered during implementation and testing of data editing using ArcSDE 8.1 and 8.2 were severe enough that the plans for full implementation were postponed.

In the meantime, it was determined that it would be more advantageous to implement Microsoft's SQL Server for both the data warehouse and eventually, data editing (see below).

Oracle currently has three major uses for enterprise GIS:

- it houses the control tables necessary for the nightly integrate/update cycle;
- it houses the data registry – information necessary for stewardship management; and
- it houses metadata tables.

At this time, many of the tables in the Oracle database serve multiple purposes, especially those having to do with metadata. In addition, the current cadastral update process is heavily dependent on the integration control tables, and cannot be easily modified. Until the new ArcGIS metadata tools are designed, built and working, and the cadastral geodatabase has been implemented, tested, and deemed the primary source for cadastral production, continuation of the Oracle tables will be necessary.

The current plan is to copy out the stewardship and control information, separate them by function, and create a new set of tables in SQL Server. It is expected that we will be able to move the metadata maintenance tables and tools straight over, as long as the new tools are adequately tested. However, since the stewardship information is so interdependent on the nightly update cycle, there will be a need for parallel systems and data synchronization between the old and new steward tools.

In addition, there will be a strong need for parallel systems and synchronization between the two databases when the production database is in its testing phase. Details are outlined below.

6.2.5 Back-end software

6.2.5.1 SDE

Enterprise spatial data is stored and served through ArcSDE, which facilitates multi-user access to spatial and tabular data stored in an RDBMS. There are currently two instances of SDE running: Version 8.1 is running on Oracle, and Version 8.3 is running on SQL Server.

The attempt to use SDE 8.1 on Oracle to create a versioned, multi-user database was fraught with problems. Many were inherent to 8.1 and Oracle, and others were a result of our inexperience with setting up and using SDE and versioned geodatabases. The decision was made in mid-2002 to postpone further data development using SDE until we could get a handle on the problems that we faced.

The advent of SDE 8.3 offers better performance, better support for versioned geodatabases, support of topology, and more robust support from ESRI. However, anecdotal evidence suggests that the problems of accessing spatial data residing in versioned geodatabases outside of SDE still exist. If so, this will likely prove problematic for us as it has for others.

6.2.5.2 ArcIMS

ArcIMS application development is and will continue to be a major mechanism for distributing GIS information to internal users and the public. Development of iMAP map sets is ongoing and responsive to client needs. In addition, other ArcIMS projects outside the iMAP framework are under development.

It is expected that ArcIMS will play a significant role during and after the software migration, as many of the functions that ArcView 3.x users rely on can be ported to thin-client intranet ArcIMS applications, thus relieving the county of the burden of upgrading those users to ArcGIS.

However, it will be necessary to determine what specific ArcView 3.x functionality is used, and whether there is overlap in use and need not only within individual agencies, but across the county. This information will result in the most efficient use of developer time and dollars. This sort of study can easily be hooked to the user survey mentioned in Section 9.1.3.

6.2.6 Applications

A necessary goal of the software migration is to convert, replace, or retire all enterprise applications. There should be no enterprise applications in "legacy/still supported" status.

More detailed descriptions of enterprise applications can be found in the 2004 GIS Operations & Maintenance document.

6.2.6.1 Access, analysis, and mapmaking (end-user apps)

AVLib and KC Parcel Tools: These are the two primary data access extensions developed by the KCGIS Center for ArcView 3.x users. AVLib is an ArcView 3.x extension that provides users with streamlined methods to access and display layers in the KCGIS Spatial Data Warehouse (via shapefiles in /plibrary2). KC Parcel Tools provides users with a simple interface to access, query, and map selected Assessor's data in the KCGIS Spatial Data Warehouse.

Both of these extensions are installed on numerous user desktops in the county, and it is expected that their use will continue as long as ArcView 3.x is installed. The KCGIS Center will support each of these extensions until it is determined that such support is no longer needed. However, no new functionality will be added and no major updates to the software are planned at this time.

LibTool and ParcelTool, ArcGIS 8.x counterparts for AVLib and Parcel Tools respectively, will be developed using ArcObjects. The intent is for LibTool and ParcelTool to be modules of the larger KCTools interface, which will also include tools for stewardship. Many of the planned elements of LibTool and ParcelTool will be based on the existing ArcView 3.x applications to offer support to users transitioning to the ArcGIS environment. Additional descriptive details can be found in the O&M Document. LibTool and ParcelTool are planned for release at the same time that the SQL Server SDE data warehouse goes live.

iMAP and Parcel Viewer: These are web browser based applications developed using ArcIMS, and designed to deliver GIS and property information to a wide internal and public audience. Parcel Viewer is specifically designed to return information for property searches, while iMAP is more complex, offering the user a number of Map Sets and analysis options for a variety of GIS data.

iMAP and Parcel Viewer are hosted on the KCGIS Center's internet site (www.metrokc.gov/gis/mapportal), where they generate on the order of three million hits a month. These ArcIMS applications rely on data managed by the SQL Server database and ArcSDE, so are already well-integrated into the new regime. Enhancements to these applications, and development of new ArcIMS applications are detailed in the O&M Document, and they should not be affected at all by the software migration.

Districts and Development Conditions Report and KC Property Report: While these two ASP applications can stand alone, they are most often accessed via links from iMap and Parcel Viewer. The D&D Report utilizes ArcIMS, and both connect to the Oracle database.

Like iMAP and Parcel Viewer, these applications are hosted on the KCGIS Center's internet site. Neither will affect or be affected by the software migration, and neither will need adjustment during or after the software migration.

6.2.6.2 Stewardship and metadata tools

Sitetool: Sitetool allows KCGIS data stewards to maintain and update their spatial and organizational information. Sitetool will be replaced by StewardTool, an ASP application hosted on the KCGIS Center intranet. StewardTool will need to be tested and fully deployed before the production database is in place.

Doctool and Docgen: Doctool is an AML application that was developed a number of years ago to fill a gap in ESRI software, and allows data stewards to create and maintain metadata for spatial objects and their associated features. Docgen is a set of routines that create content for the Spatial Data Catalog in KCGIS and FGDC compliant formats. The metadata functionality offered with ArcGIS is robust, complete, and – for all purposes that we can see – fully adequate to meet our needs.

It is expected that the input and management functionality offered by ArcCatalog, coupled with the deployment functionality of the ArcIMS Metadata Server, will replace that of Doctool and Docgen, hopefully with a minimum of customization effort. However, these options have not yet been fully explored.

Since all three of these tools rely heavily on direct query of coverages in the data warehouse, they will become obsolete very quickly, and should be high on the priority list for replacement.

6.2.6.3 Data update and management tools

Keytool: Keytool is an AML editing interface that allows users to create and maintain polygon keyfiles that describe GIS datasets conflated to the KCGIS cadastral superset coverage, RECDNET. It is rarely used. Topology editing rules implemented in ArcGIS 8.3, specifically the

"must be covered by feature class of" rule, should replace the need for Keytool. Keytool will be retired when it is determined that it is no longer being used.

MaintRec: The MaintRec tool is an AML editing interface that provides King County agencies with a set of tools to populate tiled edit coverages with new or updated features. It is used exclusively by KCA to update the cadastral base. MaintRec will be retired once the cadastral geodatabase is live.

Integrate and Update: These are AML-driven back-end applications that comprise the bulk of the nightly database update processing. Integrate tests and incorporates the updates generated by King County agencies for their layers derived from the framework RECDNET and RECDANNO layers, while Update locates, validates and posts keyfiles, coverages, and Arc/Info Export files to the coverage warehouse. A separate automated process creates and exports shapefiles to the shapefile warehouse. All of these routines will be retired when it is determined that no enterprise coverage editing and posting is occurring.

6.2.6.4 Support options in a mixed environment

A mixed environment is inevitable, and during that time the KCGIS Center and GIS staff in individual agencies will be tasked with providing support to users who have migrated, those who are in the process of migrating, and those who have yet to migrate. The only option to avoid an overly protracted period of dual support is to make sure that stewards and users are migrated in as timely and efficient a manner as possible.

In addition, there may be users who will not migrate at all to the ArcGIS platform, either because they will eventually move from ArcView to an ArcIMS or other thin-client application, or because they are very low-level users who can get by with ArcView and shapefiles for the foreseeable future. Support for these users after the geodatabase data warehouse has been implemented will be limited to the continuation of the shapefile library.

The support options for these users need to be determined before the migration gets well underway. While support for them should not be totally cut off, it is still desirable to discourage these users from hanging onto ArcView indefinitely.

6.3. Setting up the Geodatabase

Since production databases and data warehouses require significantly different architecture to operate optimally, separation of these two types of databases has become an industry standard.

There are two primary goals of the data warehouse reorganization:

- Discontinue the use of coverages as the primary source for enterprise GIS data, and in its place, create an enterprise data warehouse that contains relevant, current, accurate, and documented spatial data that is of interest to King County GIS, its agencies, and the public. The primary format of the data warehouse will be SDE geodatabase running on Microsoft SQL Server.
- Decouple the data warehouse from the production area in order to optimize both.

The current production/warehouse setup on *WILDFIRE* consists of two read-only warehouses (/plibrary for coverages, and /plibrary2 for shapefiles), a production area (/projects and /maint), and a transfer area (/post). The production area is open access, and access to the transfer area is limited by agency.

Currently, the link between the production area and the data warehouse is tenuous and optional. The production area does not contain a full working copy of the data warehouse. Data stewards either keep a working copy of a given layer in their own area and post when necessary, or they make a copy of the layer from the warehouse, make their changes, then post it back.

The advent of defined relationships and topology-based editing in the geodatabase will necessitate a change in the way the production area and the data warehouse interact. The production area will still be relatively open-access, and the data warehouse will still be read-only. But it is conceivable that the production database will become in essence an editable "full working copy" of the data warehouse. Or the converse mode of thought is that the data warehouse will become the "last posted official version" of the production area. Defining the relationships between the production and warehouse databases will be among the first tasks of implementation.

6.3.1 The Data Warehouse

6.3.1.1 Current status

The implementation of the SDE-driven data warehouse is already underway. GISSQLDW is currently online in test mode, running SQL Server 2000 and SDE 8.3, and is available to users with ArcGIS version 8.3 (or above). There is currently one user database defined, named Plibrary.

Vector layers: A number of layers have been imported from the enterprise coverage warehouse (/plibrary) and are currently used heavily by ArcIMS, and less heavily by other users.

Imagery: New imagery and certain legacy imagery has been and will continue to be loaded into SDE on GISSQLDW. There is no intent to remove existing legacy imagery from its current file-based location on a separate server.

Loading imagery into SDE takes a great deal of time and CPU resources; therefore, the goal is to perform this action as few times as necessary to get acceptable results. As of the publication of this document, some of the imagery library is stable and accessible to users with ArcGIS version 8.3 or higher. Other imagery is scheduled for completion of pre-processing and subsequent loading later in 2004.

Non-image raster data and TINs will not be supported until ArcGIS version 9.x. The few users who have a need to directly access this sort of data (as opposed to derivative data such as vector contours), will need to upgrade to 9.x when they are able. They should be made aware, however, that their level of support from the KCGIS Center may be adversely affected if the current supported version is 8.3.

6.3.1.2 Design and Implementation

The data warehouse will consist of an SDE instance that is read-only and without relationships or topology. Major schemas will be the same as the existing libraries in the coverage/shapefile warehouse.

Implementation of the Data Warehouse is highly interdependent on the data migration, which is outlined in Section 7.2.

In essence, there are two options:

- Call the existing SQL Server SDE instance the new Data Warehouse, and proceed accordingly
- Create a new instance of SDE on SQL Server, retire the existing instance when it is certain that no users or applications are utilizing it (the biggest being ArcIMS), and proceed accordingly.

The data warehouse option that is chosen will depend entirely on which data migration option is chosen.

6.3.1.3 Timelines

The technical aspects of setting up and implementing the Data Warehouse can be completed in a relatively short period of time. It is the actual migration of data into the Data Warehouse that will be time-consuming.

6.3.2 The Production Geodatabase

6.3.2.1 Current status

The Oracle database on *WILDFIRE* is currently acting as the production geodatabase, in that the layers that it contains are openly available for editing. However, the Oracle geodatabase is not a complete set of spatial data maintained, nor (with a few exceptions) are layers in the Oracle instance maintained in SDE. Rather, they are imports of their respective coverages, updated manually on a semi-regular basis.

There is no intention that the Oracle instance will be considered as the production database during or after migration. The unnamed enterprise server that was acquired in 4th Quarter 2003 is slated to serve that purpose, and will be set up as a SQL Server instance. Until it is online, however, users wishing to familiarize themselves with SDE and the geodatabase are encouraged to use the Oracle instance with the understanding that there are some differences between Oracle and SQL Server implementations.

6.3.2.2 Implementation

The design and implementation of the production database will need careful planning and cross-agency communication to ensure that agency business needs are met. Eight agencies plus the KCGIS Center maintain the vast majority of the data layers, including all of the core layers. The disparate nature of these agencies and the network issues associated with linking remote sites results in a set of unique challenges:

- Many agencies spawn their own copies of warehouse data. Often the issue is that the local copy is more reliable than accessing over the network; however, agencies often join their own internal data to the spawned layer for the convenience of their analysts and users.

- DDES and Transit will not be utilizing enterprise servers to maintain their data. Transit has been working to develop the regional *T*NET project, which will be housed within their agency; DDES is in the process of implementing SDE at their site. For both of these agencies, replication data to the enterprise warehouse will be an issue, especially for DDES, which is a remote site.

- For agencies which do not use the enterprise server for data maintenance, what is the best way to post their data to the data warehouse? Should mechanisms be put into place that allow direct posting (after QA/QC), or should that data first be posted to the enterprise server, where it can be dealt with by a nightly updating routine?

- There are necessary relationships between the core layers, which would require under current technology restraints that they all reside in the same dataset. Datasets have a practical limit on size, which we would easily exceed due to the number of core layers and the immense size of some of them (particularly the parcel layer). The fact that maintenance is performed by multiple agencies makes this a technical impossibility. This is an issue that will need to be addressed early in the design phase of the migration.

6.3.2.3 Timelines

The technical aspects of setting up and implementing the Production Geodatabase can be completed in a relatively short period of time.

7 Migrating the Data

7.1. Data Review and Optimization

The software migration offers a unique opportunity to evaluate existing data for use and effectiveness. A number of the peer agencies took the time and effort to do so, and none were disappointed either in the effort or in the results.

The King County coverage warehouse (/plibrary) was set up and optimized for coverages; the shapefile warehouse (/plibrary2) is merely a direct conversion of the coverage warehouse. If we are to consider the geodatabase as our primary format for maintaining and accessing spatial data, it is imperative that the data be appropriately optimized for the task.

One example of this need is lookup tables (LUTs). When the coverage warehouse was being built, data normalization was required in order to optimize disk space. Now that physical hardware storage is no longer a constraint on data size, ESRI highly recommends that data that relies on lookup tables be denormalized into attribute domains in order to make the best use of geodatabase functionality.

This is also an excellent opportunity to review, revise, and update metadata to make sure that it meets the requirements set forth by the Best Practices Committee.

Finally, while there is no need or intent to migrate imagery, there will be a need to ensure that those using ArcView 3.x or MapObjects do not lose access to the existing imagery.

7.1.1 The layer review process

Each reviewed layer should go through a formal process with documented steps:

- an evaluation of its fitness to continue its existence in the data warehouse;
- a metadata review;
- optimization for geodatabase.

Much of the work involved will by necessity be performed at the agency level, since data stewards are ostensibly the most knowledgeable about their own data. However, guidance from the KCGIS Center, and a great deal of cross-coordination will be necessary to keep the process on track as well as determine use and effectiveness of specific data layers.

The first step must be to prioritize existing layers for migration, assuming that all layers are candidates for be migration. This will provide the framework in which to conduct the main part of the review.

7.1.1.1 Preliminary Fitness Review

This is the preliminary process by which a data layer's suitability and fitness for continuation is determined. If a layer is determined to be fit for continuation, there must be an additional determination of what needs to be done in order to prepare the layer for inclusion in the geodatabase data warehouse.

For each data layer, the following questions should be answered:

- Should we keep it?
    - What is its purpose, audience, intended use and restrictions?
    - Is it obsolete (still applicable to county needs)?
    - Is it used?
    - Can it be replaced with more current or useful data?
    - Can/should it be combined with other existing data?
    - Is it redundant, and if so, with what? Are they both necessary, and if not, which layer should stay? If both stay, are they documented adequately so that uninformed users can choose the correct layer for their needs?
- Is the actual data correct, accurate and within acceptable precision?
    - If not, should/can it be made so, and what are obstacles?
- What is its migration priority?
- Is the metadata complete and up-to-date?
    - Is there an appropriate keyword list?
    - Minimal metadata exists as defined by the Best Practices Document.
    - If not, what are obstacles to making it so, and how will they be overcome?
    - Is there additional documentation that needs to go into the metadata
- Is the documented steward appropriate?
    - Do the contacts actually know anything about the data?
    - If not, who inherits it?
- Is each and every field useful, documented as to purpose, and coded?
- Is there work that needs to be done to make the data better/more useful (the work is not necessarily performed at this time, merely documented as part of the metadata process)
- other questions as needed.

It should be noted that many of these questions that answer the “should we keep it” question are fundamental metadata elements. Therefore, if a succinct abstract statement, a succinct purpose statement, and appropriate keywords for a given layer cannot be formulated, then that layer must fail the preliminary fitness review.

Additionally, unless a data layer is truly likely to be dropped, it is highly recommended to go ahead and fill in metadata gaps where encountered at this step to avoid duplication of work that will be required in the next step.

The preliminary fitness review can take place either on a layer-by-layer basis as the data migration proceeds, or it can take place in a “batch” mode whereby all layers in /plibrary are evaluated before beginning the optimization process on any layer.

The second option (“batch” mode) is recommended:

- It would result in a “clean” slate for the data review process;
- it would also get everyone involved with maintaining GIS data thinking about their data layers early and often;
- the rest of the migration process will become more focused and streamlined;
- once it is complete, every layer is assured to be relevant.

In order for this to be a viable option, though, the batch preliminary process will need to be completed in a relatively short period of time so that optimization and migration can begin in a timely manner.

It is expected that there will be few layers that will fail the fitness review outright; however, it is also expected that there will be a limited number of layers that will need close cross-agency scrutiny, as they have been of dubious stewardship in the past.

7.1.1.2 Metadata Review

Metadata management is an important part of data warehousing. According to the Best Practices document (approved by the Oversight Committee in August, 2002), "Current, descriptive metadata adhering to content standards should be maintained for all shared data sets."

Since metadata review is not a direct process on the data itself, gaps in metadata may be filled in at any time prior to the inclusion of the layer into the geodatabase. While it is certainly possible to develop and maintain metadata after the inclusion, the recommendation is that lack of acceptable metadata be grounds for non-inclusion.

While the FGDC standard does not officially recognize the concept of "metadata lite," that is, declaring a subset of the standard to be acceptable, this is an accepted practice in the GIS community. The Best Practices Committee has determined the FGDC subset that is acceptable for King County Spatial Data metadata, and it is this subset that should be considered the minimum for a layer to pass the metadata review. Minimal requirements are listed in Appendix D.

7.1.1.3 Optimization

Once a layer has passed the preliminary "continued existence" review, it should be optimized for inclusion in the geodatabase.

The first step must be an evaluation of how the layer interacts with other layers, as certain layers will almost certainly need to be processed together.

- What layers does this one depend on (for example, a number of layers are derived from the parcel layer – when it changes, they must also change)
- What layers depend on this one?
- If the layer has dependencies, there will need to be cross-agency coordination to ensure that layers are properly optimized.

One method that can be employed is the creation of an Entity Relationship (ERD) diagram, a data modeling technique that creates a graphical representation of the entities and their relationships within an information system. In our case, the entities are data layers.

Other steps of the process include:

- denormalization – its lookup tables should be incorporated into the layer as retained fields in the attribute table.

- relationship classes – are there any business tables that the layer relates to that should not be incorporated into the geodatabase?
- topology rules – what topology rules should be set up for this layer, that is, how does this layer relate to itself and other layers?

Once a layer has been optimized and then posted to the data warehouse, and is no longer edited on coverage format, it will be considered migrated.

7.1.1.4 Optional final review

It may be necessary to perform a fast "final review" of the data. This should be done consistently by the same single person or small group. This review should be performed before the layer is posted to the geodatabase data warehouse, and should verify that metadata is complete and acceptable, and that the changes that were made are consistent with the rest of the geodatabase structure and function.

7.1.1.5 Order of operations

There are a number of ways in which the data review can take place, depending on the order in which data are loaded into the database relative to review. These options are detailed in Section 7.2.

7.1.2 Which data should be reviewed?

There are three basic categories of data that exist in /plibrary:

- Internal: data created and maintained by King County agencies;
- Externally-sourced: data obtained from external sources which is not modified from its original state except to correct for projection and name limitation issues;
- Externally-obtained: data obtained from external sources which is modified by a King County agency to add value.

The data review should be as comprehensive as possible. Every layer in /plibrary should undergo the preliminary review process. In addition, internal and externally-sourced data should undergo the optimization process.

7.1.3 Roles

The Software Migration Workgroup (see Section 11.1 for definition) is the logical entity to take a central role in assisting the GIS Data Coordinator to develop the data survey. In addition, this group will be in an excellent position to assist agencies with prioritizing, reviewing and preparing data for inclusion into the geodatabase, as well as dealing with timelines, communication, and overall coordination.

KCGIS Center staff will need to be available to assist the Software Migration Workgroup and data stewards with the technical aspects of the geodatabase. In addition, while the KCGIS Center will likely take the lead role in the conversion of enterprise layers, input from agencies, especially with respect to prioritizing, will be necessary.

7.2. Data Migration

7.2.1 Migration options

Data migration is certain to be a time-consuming process, given the number of stewards throughout the county, and their wide range of resources available to proceed with migration.

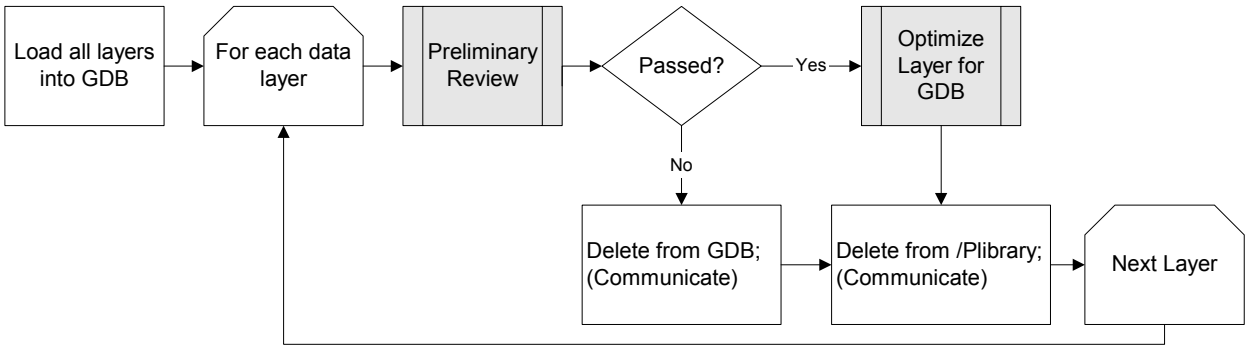
In its final format, the data warehouse will consist of a single SDE/database instance that contains all King County enterprise spatial data in optimized geodatabase format. However, in order to achieve this goal, intermediate steps are necessary. The options that are available are highly interdependent upon the options and ultimate course of action taken with the data review and optimization process outlined in the previous section.

Each of these options assumes the following:

- External data is loaded from coverage "as is;" no attempt will be made to optimize for geodatabase.
- Imagery loaded into geodatabase format is considered finalized.
- All internally-generated spatial layers are subject to this process except the cadastral layer RECDNET.
- Once a layer is optimized for geodatabase and finalized in the new data warehouse, support for editing the coverage version will necessarily cease. In the figures below, the assumption is being made that this entails deletion of the coverage layer from /plibrary, but this may not be the case, as is detailed in the next section.
- The Preliminary Review step includes the evaluation or creation of succinct abstract, purpose and keywords.
- The rest of the Metadata Review can take place at any time after a layer passes Preliminary Review.
- The Final Review step is not included in the options listed below, as it can logically be placed as part of the Data Optimization step.

There are two "families" of options, depending on when the Preliminary Fitness Review is performed. The first family (Options 1 – 3) assumes that the preliminary fitness review is incorporated into the overall migration process for a given layer. The second family (Options 4 and 5) assumes that the preliminary review process has been completed before any data migration takes place.

7.2.1.1 Option 1: Load, review, optimize

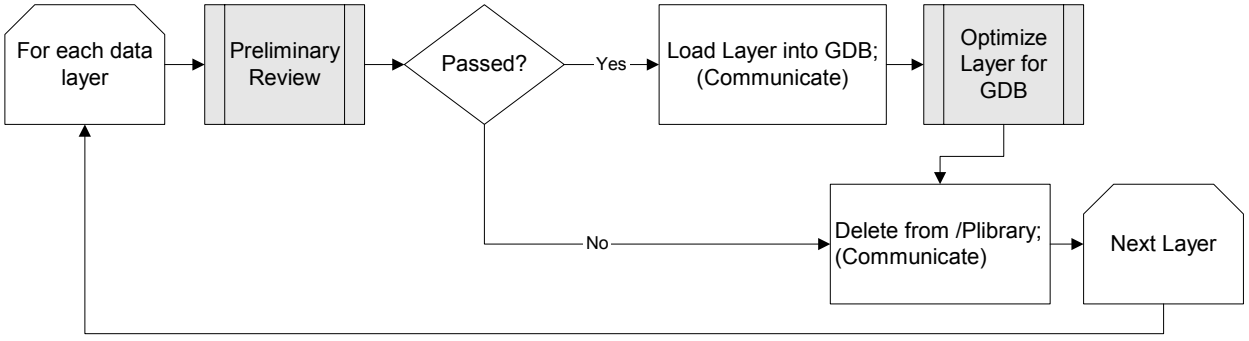


All vector layers except RECDNET are converted from coverages and placed in the SDE warehouse as-is. Each layer then enters the two-step review process. If a layer fails the preliminary review, it is deleted from both the data warehouse and /plibrary. If it passes, the layer is then optimized for the geodatabase. The old layer is left in place while optimization takes place outside of the data warehouse. Once the process is complete, the old layer is replaced with the new layer.

This option allow users immediate access to all geodatabase data. As the data review and migration progressed, layers would be replaced with their geodatabase counterparts. In all likelihood, since data in *some* format would be immediately available, this would be a more gradual transition to fully implementing the geodatabase data warehouse. Additionally, since many layers are have already been loaded into the SQL Server database and are currently being used, this option would requires less time for the initial setup. However, this option results in a data warehouse that has a mix of irrelevant, optimized, and non-optimized layers residing in the same instance. The possibility that obsolete data would be propagated to the new system is much higher than in other options, since the "do nothing" scenario leaves that data in the data warehouse.

Also, since all layers are in the geodatabase, this option requires some sort of outside layer tracking mechanism for users to quickly ascertain the status of individual layers.

7.2.1.2 Option 2: Review, load, optimize

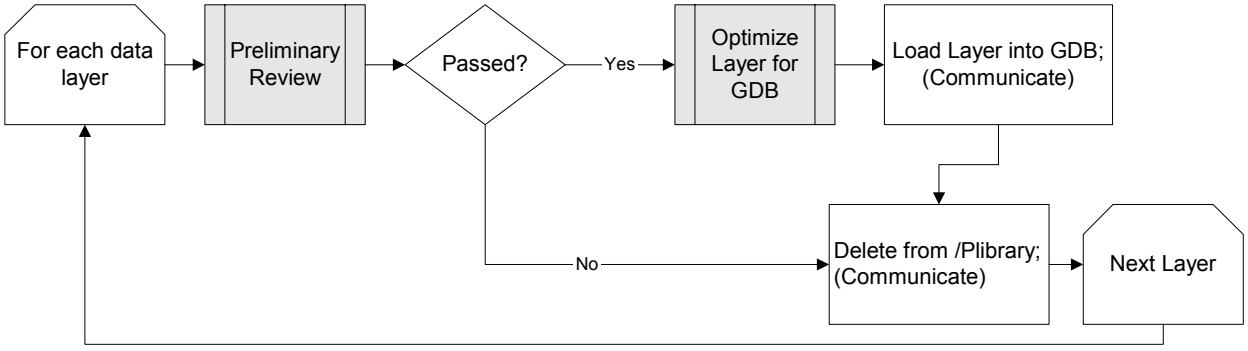


This option splits the two parts of the review process. For each layer, the preliminary layer review takes place first, then (assuming it is passed as fit to continue) then the layer is copied to

the geodatabase warehouse. Then it is optimized for the geodatabase. The old layer is left in place while optimization takes place outside of the data warehouse. Once the process is complete, the old layer is replaced with the new layer.

This option ensures users that every layer in the data warehouse is relevant – that is, it has passed the preliminary review process. However, like Option 1, this option results in a mix of optimized and unoptimized layers in the same database instance, has the same advantage of pre-loaded layers, has the same possibility of a longer migration process, and will require a layer tracking mechanism so that users can easily ascertain the optimization status of a given layer.

7.2.1.3 Option 3: Review, optimize, load



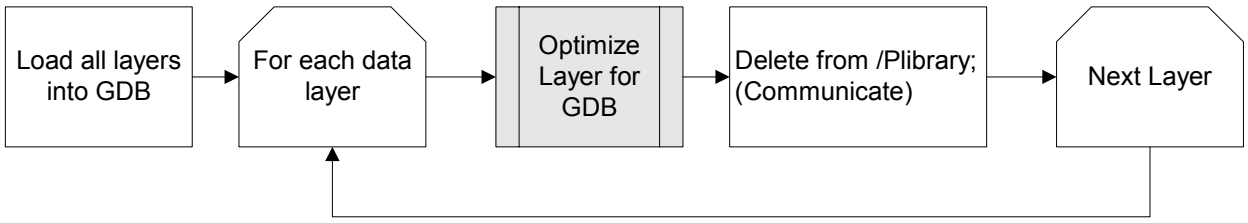
Each layer undergoes preliminary review and optimization before being loaded into the data warehouse. The result is that only that subset of KCGIS data that is relevant and optimized resides in the data warehouse.

This option ensures that all data in the warehouse is correct, necessary, meets all standards, and is optimized to use the full potential of the geodatabase. However, the data is unavailable in the new geodatabase format until it has been migrated. This might be problematic for some users. In effect, it restricts access to data that may have a lower priority for geodatabase optimization, even if it is considered relevant.

This option will create a heavy impact on ArcIMS, as it is completely reliant on the layers in the existing instance of SDE. The existing instance of SDE cannot just disappear, so will need to be restricted to IMS-only access. As layers are added into the new data warehouse, ArcIMS administrators will need to point their applications accordingly.

This option creates the most motivation on the part of data stewards to complete the review process, but also may create an atmosphere in which stewards feel pressured or overburdened to get their data “out there.”

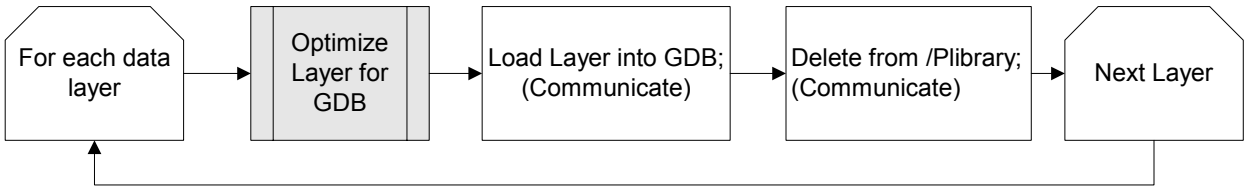
7.2.1.4 Option 4: Load, Optimize



All layers have already undergone preliminary review and are assumed to be valid and necessary. All vector layers except RECDNET are converted from coverages and placed in the SDE warehouse as-is. Each layer then enters the optimization process. The original (converted) layer is left in place while optimization takes place outside of the data warehouse. Once the process is complete, the original layer is replaced with the new layer.

This option has the same advantages and disadvantages as Options 1 and 2 above, most notably the immediate access to SDE data (on the plus side), and the mixed environment of migrated and non-migrated layers (on the minus side).

7.2.1.5 Option 5: Optimize, Load



All layers have already undergone preliminary review and are assumed to be valid and necessary. Each layer undergoes optimization before being migrated to the data warehouse. The result is that only that subset of KCGIS data that is relevant and optimized resides in the data warehouse.

This option has the same advantages and disadvantages of Option 3 above, most notably the assurance of optimized data (on the plus side), and the unavailability of data until it is optimized (on the minus side).

7.2.1.6 Summary of Data Review/Loading options:

	Preliminary Review Integrated			Preliminary Review Already Complete	
	Option 1	**Option 2**	**Option 3**	**Option 4**	**Option 5**
General:					
Potential for propagation of irrelevant or grossly incorrect data	very high	low	low	low	low
Need for communication	high	high	high	high	high
Type of communication	on determination of layer deletion or layer migration	on layer migration	on layer load	on layer migration	on layer load
Preliminary review	after load	before load	before load	N/A	N/A
Metadata review	any time before final acceptance	any time before final acceptance	any time before final acceptance	any time before final acceptance	any time before final acceptance
Optimization	after load	after load	before load	after load	before load
Content: optimized vs. non-optimized	mix	mix	all optimized	mix	all optimized
Content: relevant vs. non-relevant	mix	all relevant	all relevant	all relevant	all relevant
Users:					
Access to data warehouse	immediate	immediate	delayed	immediate	delayed
Surety of data relevance	none	very	very	very	very
Surety of data optimization	none	none	very	none	very
Stewards:					
Speed of transition	gradual	optional	fast	optional	fast
Pressure to optimize	less	less	more	less	more

7.2.2 Impacts

7.2.2.1 Impacts on coverages

Once a given layer has been migrated to the geodatabase, posting new versions to the data warehouse in coverage format can no longer be supported. However, the question remains as to

whether to keep the new version of the layer in coverage format. Ultimately the coverage warehouse (/plibrary) will be discontinued completely; the decision that must be made is how.

Option One: dismantling piecemeal. Once a layer is migrated, its (former) coverage version in /plibrary is archived then deleted, along with its control information. Under this scenario, all coverages except the cadastral base would eventually just go away (the cadastral base will be dealt with as part of the Cadastral Migration).

This option would have no impact on the majority of users who use shapefiles, but would force those whose applications and map projects rely on coverages to either convert entirely to geodatabase or shapefiles, or constantly scramble to update their applications to point to the geodatabase data warehouse on a layer-by-layer basis.

Option Two: export to /plibrary from GDB. Disallow the posting process for coverages as they are migrated to the geodatabase. The old coverage version of the layer is archived, then replaced with an export of the new geodatabase layer. When every layer has been optimized, then the coverage warehouse can be discontinued (except for the cadastral base).

This option is not viable. There are significant differences between the old and new geometry data models that make the export process difficult and highly unreliable. Poor rendering of "true curves" in the geodatabase results in corrupt coverage data; the geodatabase allows longer field names than coverages; and coverages must be cleaned, which often results in position creep. The resulting coverages are often corrupt, and will not synchronize exactly with their geodatabase counterparts.

Option Three: obsolete copy. Disallow the posting process for coverages as they are migrated to the geodatabase. The last version of the old coverage is kept in /plibrary, but is not updated when the geodatabase version is changed (see above discussion on exporting to coverage format). When every layer has been migrated, then the coverage warehouse can be discontinued (except for the cadastral base).

This option allows ongoing access to some sort of coverage version, even if it is old; however users would need to be strongly (and repeatedly) cautioned that the coverage version is not the latest. This solution is more effective for those layers which do not change on a regular basis and whose optimization for inclusion in the GDB would have minimal impact on the basic definition of the layer. Other layers which are updated frequently would quickly become asynchronous with their coverage counterpart.

Summary of Coverage Options:	Option1	Option 2	Option3
/plibrary dismantle procedure	as layers are migrated	after all layers migrated	after all layers migrated
Viability given current technology	very	not	very
Impact on coverage users / applications	very high	little	medium to high, depending on the layer
GDB synchronous with /plibrary	N/A	very	not

7.2.2.2 Impacts on shapefiles

It is understood that shapefiles are a major GIS data format, and will be so for some time. The anticipated timeframe to convert end users to either ArcGIS and the geodatabase or, most likely, an ArcIMS-based client application, will necessitate the retention of shapefiles for that duration. Therefore, there is no plan to discontinue the shapefile warehouse (/plibrary2) in the foreseeable future.

The impact on the shapefile library should be minimal. As layers are migrated, the old version of the shapefile will be archived, and the new version will be exported from the SDE data warehouse. Subsequent edits to the optimized geodatabase layer will be replicated in the shapefile library as in past practice.

The denormalization process will cause many of the layers to increase in size. Denormalized layers incorporating many formerly joined tables may create generated shapefiles that are too large and unwieldy for ArcView 3.x users to handle. An attempt should be made to identify potential problem layers, and one of them should be an early prototype, so that the different export scenarios can be tested in order to best support ArcView 3.x users.

7.2.2.3 Impacts on existing enterprise applications

ArcIMS: As layers undergo the transformation that optimizes them for the geodatabase, ArcIMS will be heavily impacted by loss of access and/or necessity of changing code on a frequent basis.

Options 1 and 4 offer the least impact to ArcIMS applications, as the current, populated instance of SQL Server that most of these applications use would not initially change except for the loading of additional data. The likelihood of layers that ArcIMS uses failing their preliminary review is small.

Options 2, 3 and 5 require a layer to pass preliminary review and/or optimization process before being loaded into the data warehouse. All of these options would require a separate access-restricted instance for ArcIMS, as they result in a data warehouse that is not complete until the entire process is finished.

AVLib: There should be no impact on AVLib, as it accesses the shapefile library and the imagery portion of the geodatabase data warehouse.

Other applications: Impacts on other applications will need to be determined before an option is chosen.

7.2.3 Implementation

Prioritizing and grouping layers, both those managed by KCGIS Center and those managed by agencies, will necessitate a considerable amount of communication on the part of agencies, the KCGIS Center, the Technical Committee, and the Best Practices Committee.

The recommended data migration option is Option 4. This option requires the Preliminary Data Review to be complete before the data migration process begins, so that every layer in /plibrary is relevant. All vector layers are converted from coverage and loaded into the data warehouse. Optimization of individual layers will take place in the production warehouse, then the layer will

be migrated when it is ready (either the data steward or the Final Review committee makes this determination).

Reasons:

- Access to geodatabase data warehouse to everyone from the start. This allows users the opportunity to learn how to work with read-only SDE data on their own timetables.
- Ease of editing metadata. All layers must be in the SQLServer geodatabase in order for stewards to use ArcGIS tools to complete the metadata review process. Options that require data optimization before loading into the warehouse would force stewards to use ArcGIS tools instead of the legacy (and widely disdained) Doctool AML application.
- Minimal impact on ArcIMS and other applications using SDE. Instead of dealing with changing from coverages to geodatabase on a layer-by-layer basis every time a layer is migrated, and dealing with "Where's the data?" syndrome, application administrators and developers will just need to verify how the new optimized format of the data fits with their applications.
- More transparency to the users. Users don't have to think "Where's the data?" However, they may still need to deal with "Is this layer migrated?"

8 Licensing

8.1. Background: Licensing the ESRI Way

8.1.1 Types of ESRI Licenses:

- A single-use, or "standalone," license is a single seat that runs only on the machine on which the software is installed.

- Floating licenses are seats that are served by a license manager, and can be run by anyone who has access to the machine. The server may host one or more floating licenses on the same license manager.

- A concurrent-use license is the same as a floating license.

- Node-locked licenses are also served by a license manager, but users must be logged onto the server that hosts the licenses. Node-locked licenses are only available in packs of three seats; that is, one node-locked license allows three users to access the software at the same time. ESRI no longer offers node-locked Arc/Info licenses for purchase.

8.1.2 Maintenance

ESRI offers the opportunity to purchase maintenance on certain licenses for an annual fee. For other licenses, such as concurrent ArcGIS licenses, annual maintenance is mandatory. Licenses under a maintenance agreement have automatic version upgrades, limited support, and in some cases, waived registration fees at ESRI's annual User Conference.

Licenses under maintenance are designated as either Primary or Secondary. The first license of a given software is always Primary, as are all subsequent 10^{th} licenses (i.e., the 11th, 21st, etc.). All other licenses can be designated as Secondary, which have nearly the same level of support (lacking only complimentary User Conference registration), but cost substantially less to maintain.

Maintenance is complimentary for the first year following the purchase or upgrade of an ESRI software license.

8.1.3 Extensions

The major extensions can be treated the same as the core software, as license types and maintenance options are more or less the same, but with more limited support.

License migration paths for extensions are shown in the below table.

Arc/Info 7.x	ArcView 3.x	ArcGIS 8.x
Grid	Spatial Analyst	Spatial Analyst
Tin	3D Analyst	3D Analyst
COGO	- none -	Arc/Info / Survey Analyst *
Network	Network Analyst	Network Analyst (available at version 9.x)

* Arc/Info 8.3 incorporates much of the functionality found in COGO; Survey Analyst offers additional advanced survey functionality.

8.2. Current Status of Licenses in King County

8.2.1 Licenses

The types and distribution of core software licenses are shown in the table below. Unless otherwise noted, all Arc/Info 7.x, Arc/Info 8.x, and concurrent-use ArcView 8.x licenses are currently under standard maintenance agreements as defined above, while all ArcGIS 8.x standalone and ArcView 3.x licenses are not. Primary and Secondary maintenance costs are borne by the individual agency.

Agency	Arc/Info: 7.x				ArcGIS 8.x: ArcInfo			ArcGIS 8.x: ArcView			ArcView 3.x
	Node-locked seats		Floating		Concurrent		Stand-alone	Concurrent		Stand-alone	
	Pri.	Sec.	Pri.	Sec.	Pri.	Sec.		Pri.	Sec.		
Budget										1	1
KCA	3	6								1	22
DDES					1	2					20
PubHealth											8
FMD											2
OEM											3
REALS			1								5
GISC	3	12	1	2	1	6		1	9		20
Parks						1					6
SWD											2
WTD						1					5
WLRD					1	3		2	13		59
KCIA										2	0
Roads					4						35
Transit			1	2	1	1		1	4		27
Sheriff											4
Council											2
Totals	**24**		**7**		**22**		**0**	**30**		**4**	
	31				**22**			**34**			**221**

There is one additional ArcInfo 8.x license that resides at an offsite WTD location. It is used for a single project (I/I), and is unavailable to other users. Therefore, this license is outside the scope of the software migration discussion. If this license becomes repatriated at a later date, any costs involved will be dealt with at that time.

8.2.2 Current Pricing

Current pricing (2003-2004) is listed in the below table. These are the numbers that will be used for the later analysis.

Arc/Info 7.x Node-locked 3-pack	
Primary Maintenance	$3,800
Secondary Maintenance	$1,450
Arc/Info 7.x/8.x Concurrent-use Only	
License	$7,100
Primary Maintenance	$2,050
Secondary Maintenance	$1,040
ArcEditor 8.x Concurrent-use Only	
License	$6,300
ArcView 8.x License	
Single Use	$1,200
Concurrent-use	$2,800
ArcInfo (ArcGIS) Extension Concurrent-use	
License	
Primary Maintenance	$500
Secondary Maintenance	$200
ArcGIS Extensions Concurrent-use Only	
Spatial Analyst	$2,000
3D Analyst	$2,000
Survey Analyst	$2,000
Network Analyst (available at version 9.x)	$2,000
ArcPress	$1,120
Primary Maintenance (Spatial Analyst, 3D Analyst, Survey Analyst, Network Analyst)	$500
Secondary Maintenance (Spatial Analyst, 3D Analyst, Survey Analyst, Network Analyst)	$200
Maintenance (ArcPress)	$200

8.2.3 Cost to Upgrade

Upgrade costs (2003-2004) are listed in the below table. These are the numbers that will be used for the later analysis.

From:	To Current Version of:	Cost
ArcView 2.x or 3.x	ArcView 8.x Single	$600
ArcView 3.2a	ArcView 3.3	$99
ArcView 2.x or 3.x	ArcView 8.x Concurrent-use	$2,080
ArcView 2.x or 3.x (UNIX)	ArcView 8.x Single (Windows)	$600
ArcView 8.x Single	ArcView 8.x Single	$600
ArcView 8.x Single	ArcView 8.x Concurrent-use	$1,600
Arc/Info 7.x	ArcInfo 8.x	No cost
Arc/Info Extension (any version)	Equivalent ArcGIS extension	No cost
ArcView Extension (any version)	Equivalent ArcGIS extension	Varies
ArcPress (any version)	ArcPress 8.x Single	$100
ArcPress (any version)	ArcPress 8.x Concurrent-use	$1000

8.3. Discussion

8.3.1 The Need for Standardization

It is essential that GIS agencies at King County operate on a standard version of core GIS software. The historical tendency has been for individual sites to upgrade licenses on an ad hoc basis, with little or no coordination among agencies. This software migration gives us all an excellent opportunity to standardize across agencies so that:

- all agencies are using the same version of software; and
- all agencies upgrade licenses at the same time, with coordination through the KCGIS Center.

This has a number of advantages:

- GIS staff providing support to end users do not have to deal with compatibility and version issues;
- compatibility of data sets is ensured (for example, data edited with ArcGIS 8.3 cannot be read with earlier versions);
- enterprise applications and support are consistent across agencies and users within an agency;
- end users can form a more cohesive community and leverage the benefit of the peer group for tips and networking;
- bugs and technical difficulties are more easily identified and addressed;
- knowledge base/documentation is easier to maintain and can be more tailored to the common environment;
- upgrades themselves are more uniform, and installation becomes streamlined as the same well-defined process is applied across the board.

8.3.2 Concurrent-use vs. Standalone Licenses

Nearly all ArcView 3.x licenses and extensions in the county are standalone and therefore not under a maintenance agreement. With the advent of ArcGIS 8.x, ESRI now requires annual maintenance for all concurrent-use licenses. The benefits of annual maintenance are support from ESRI and automatic version upgrades for the maintenance period.

However, the difference in cost between upgrading to a standalone versus a concurrent-use license is not trivial. For example, the difference in converting an ArcView 3.x license to a standalone versus a concurrent-use ArcView 8.x license is $1480. For agencies with budgetary concerns, and those with many licenses to convert, this difference quickly becomes an issue.

Agencies will need to determine whether the cost of concurrent-use licensing for ArcView 8.x and ArcGIS extensions is outweighed by its benefits. It may be reasonable for some agencies to lower their costs by converting their standalone ArcView 3.x licenses to standalone ArcView 8.x licenses, and sit on the recommended version until the next round of countywide ArcGIS upgrade occurs. Assuming that the next round of standardized upgrades will skip at least one version, the agencies pursuing this path will temporarily save the cost of interim upgrades. However, they will have to absorb the cost of a more significant upgrade the next time, whereas if they had upgraded to concurrent-use (maintained) licenses, this cost would be covered by the annual maintenance payments, which would likely be less expensive.

In other words, the decision to be made is whether to pay more now, or pay more later.

8.3.3 License Pooling

Concurrent-use licensing requires that the first out of each ten licenses be considered Primary, which carries a much higher annual maintenance cost. While it is certainly feasible and in some cases necessary for individual agencies to host their own license servers, there are scenarios where it is possible to save money by pooling agency licenses onto a single or a limited number of license servers. In theory, license pooling reduces the number of Primary licenses needed, reducing the overall cost. Agencies pay their portion of the cost by simple proportion of licenses to the whole.

Care must be taken, however, as it is possible for some agencies to pay in more to the pool than they would have if licensing themselves individually. Additionally, care must be taken that the savings in a given scenario are worth the initial and ongoing administrative overhead that license pooling necessitates.

Other issues that will need to be addressed before license pooling can take place include:

- Pooling licenses involves the transfer of ownership to one source, the KCGIS Center, which means that agencies must be willing to give up their ownership in order to realize decreased costs for everyone. The GIS Technical Committee will need to determine whether this is feasible and desirable within the current Operations and Maintenance situation, and if so, whether funds for payment to ESRI would be transferred to KCGIS Center, or if the cost would be rolled into O&M.

- Which server will be used? The license server will need to be both stable and accessible to all involved agencies. The logical choice would be an enterprise server managed by the KCGIS Center, but issues involving access, availability, and speed – especially for remote sites – will need to be addressed.

- Agencies need to have regular access to the number of licenses for which they are paying. This can be on the "honor system," or there may be technical methods available to enforce compliance. The GIS Technical Committee will need to create response policy for dealing with instances of denial of access due to lack of available licenses.

- One of the major "perks" to maintenance licenses is the complimentary pass to the ESRI User Conference. Currently, agencies send people to the User Conference based on their own licenses. With the pooling of licenses, and especially the drop of the number of Primary licenses, distribution of the free passes will need to be dealt with up front to alleviate problems later.

8.3.4 Determining Use and Need

Since there are so many upgrading scenarios, agencies should conduct an internal assessment of their use and need for Arc/Info, ArcView, and extensions. The simplest option is probably to conduct a user poll, either online or in person. However, participation may need to be enforced, and results may not reflect the real world, as what users *think* they do often is not what they *really* do. A more reliable option is to install tracking software on applicable servers. This method would ensure better results, but is more costly and requires more time to obtain complete and accurate results.

Conducting an internal assessment of ArcView 3.x use is especially important, as the ArcView upgrade has the highest potential cost to the county. If current ArcView users can do what they need to do with existing or future ArcIMS applications, and if future ArcIMS applications can be developed at reasonable cost, then those users should not be upgraded to ArcGIS.

Additionally, it is likely that there will be a need for more ArcView and ArcInfo licenses for the short term while we support legacy systems and implement the new systems. Some agencies (Transit, GISC) are already slowly transferring licenses from UNIX to Wintel systems, and have noticed shortages as users continue to use the old system while experimenting and getting used to the new.

8.3.5 General Upgrading Scenarios

In the sections that follow, there are many options for agencies to upgrade licenses either individually or with other agencies. Decisions that must be made include:

- How many existing licenses should be upgraded? This is especially important when considering ArcView licenses, since some users may be able to use other means of accessing GIS data besides ArcGIS.

- Should licenses be upgraded to concurrent-use or standalone, or some combination of each? Agencies will need to determine which scenario will best suit their users and their budget.

- For concurrent-use licensing, is pooling licenses with one or more other agencies a feasible cost saving measure? If so, which agencies should pool licenses for the greatest access, ease of administration, and cost savings?

Dealing with these questions and determining the best use of county funds and administrative resources will require coordination among the members of the GIS Technical Committee.

In the sections that follow, there is no way to present all possible licensing scenarios. *Costs given are worst-case* – that is, migrating all instances of a type of license without consideration of alternate ways to meet user needs. It is a near-certainty that all licenses – especially all ArcView 3.x licenses – will not be upgraded. However, there should be enough information for agencies and the GIS Technical Committee to develop their own licensing scenarios based on current and future need, and extrapolate the given numbers to get a reasonably accurate cost estimate.

Supporting tables are listed in Appendix D.

8.4. Arc/Info

All of the Arc/Info 7.x licenses owned by GIS agencies are under maintenance agreements, and can therefore be upgraded to ArcGIS (workstation ArcInfo) for no charge. But since node-locked licenses are not available for ArcInfo 8.x, conversion of these to concurrent-use licenses will result in higher annual maintenance costs for some agencies.

8.4.1 Current Cost

Four agencies maintain 31 Arc/Info 7.x licenses, as shown in the table below, at a total cost to the county of $26,610 (see Table D.1). Twenty-four of these seats are held among eight node-locked licenses at KCA and GISC; the rest are floating.

Seven agencies currently maintain 22 concurrent-use ArcInfo 8.x licenses under maintenance agreements, at a total cost of $30,960 (see Table D.2). There are no standalone ArcInfo 8.x licenses.

Total current cost to the county for Arc/Info is $57,570.

8.4.2 Conversion

As all current Arc/Info 7.x licenses are under maintenance, there is no cost to upgrade them. However, the change in maintenance fees for the former node-locked licenses at KCA and GISC adds over $10,000 to the annual cost (there is no change in maintenance for the floating licenses). The additional maintenance cost would not be assessed until the beginning of the next maintenance year anniversary date.

Converting the county's Arc/Info 7.x licenses and adding them to the existing ArcInfo 8.x licenses results in a total of 53 ArcInfo 8.x licenses distributed among nine agencies. Twelve of

these licenses incur Primary maintenance, which costs nearly twice as much as Secondary maintenance.

If all these licenses are pooled onto one license server, the need for Primary licenses drops to only six. This would result in a savings to the county of $6060 per year, as well as savings to all individual agencies, except WTD, Parks, and KCA. WTD and Parks currently pay Secondary maintenance on single licenses hosted at the KCGIS Center, and KCA would be paying a large share based on only one converted Primary license. Details are listed in Table D.4.

Depending on the type of editing that is performed, one option for all data stewards is to downgrade some or all of their ArcInfo licenses to ArcEditor. In terms of long-range planning, the savings to some agencies could be substantial (most notably KCA, which has many Arc/Info licenses to convert on a relatively limited budget). However, at this time ESRI charges more for Secondary maintenance on ArcEditor than it does for Secondary maintenance on ArcInfo. Whether this is deliberate or an oversight remains to be seen, but the result for us is that immediate downgrading of ArcInfo licenses to ArcEditor would not be cost effective. The Master Purchase Agreement (MPA) is due to be renegotiated in 2005, at which time we hope to obtain a more equitable pricing structure with respect to ArcEditor. In the meantime, agencies will need to determine whether ArcEditor is sufficient for their needs and be prepared to act accordingly when the MPA is renegotiated.

8.4.3 Summary

The table below is a summary of Tables D.1 through D.4. Pooling costs are based on a single common license server.

Summary: Arc/Info Conversion Cost

Agency	Cost for current 7.x Licenses	Cost for Existing ArcGIS	Cost for converted 7.x Licenses	Total Cost on Upgrade (non-pooled)	Total Cost on Upgrade (pooled) *	Pooling Difference *
Budget						
KCA	6700		10370	10370	10389	-19
DDES		4130		4130	3463	667
PubHealth						
FMD						
OEM						
REALS	2050		2050	2050	1154	896
GISC	13730	8290	20740	29030	28858	172
Parks		1040		1040	1154	-114
SWD						
WTD		1040		1040	1154	-114
WLRD		5170		5170	4617	553
KCIA						

Roads		8200		8200	4617	3583
Transit	4130	3090	4130	6210 **	5772	438
Sheriff						
Council						
Totals	26610	30960	37290	67240	61180	6060
	57570					

* Rounded to the nearest dollar.
** Transit loses a Primary license on internal agency license consolidation.

8.5. ArcView 3.x

There are 221 ArcView 3.x licenses in the county; every agency has at least one except KCIA. All of these licenses are standalone installations, and are not covered by any maintenance agreement.

8.5.1 Current Cost

Current cost for the 221 standalone ArcView 3.x licenses is zero.

8.5.2 Conversion to Standalone ArcView 8.x

Conversion from ArcView 3.x to standalone ArcView 8.x is a flat fee. If all existing ArcView 3.x licenses are converted to standalone ArcView 8.x, the total cost to the county is $132,600 (see Table D.5 for agency details).

Since these licenses are not concurrent-use, there is no maintenance charge associated with them, and also no opportunity to pool licenses. Maintenance costs for the existing concurrent-use ArcView 8.x licenses would not change.

8.5.3 Conversion to Concurrent-use ArcView 8.x

Conversion of ArcView 3.x licenses to concurrent-use ArcView 8.x is much more expensive than to standalone ArcView 8.x. If all existing ArcView 3.x licenses are converted to concurrent-use ArcView 8.x, the total cost to the county is $459,680 (see Table D.6 for agency details).

In addition, annual maintenance on concurrent-use licenses is mandatory. However, maintenance fees for the first year are complimentary, so those costs would not have to be borne until the second year. At that point, the total annual maintenance for all ArcView 8.x licenses would be $131,700 per year (see Table D.7).

ESRI has stated a willingness to work with the county on the price of ArcView upgrades. They have offered us a 20% discount off the listed MPA price, but only with a minimum order of 100 licenses. Assuming that this is even feasible from our multi-departmental budgetary viewpoint, the Technical Committee would need to carefully assess whether the budgetary complexities and administrative overhead involved would make pursuing this option worthwhile.

Since the major cost with converting ArcView 3.x to 8.x is the conversion itself and not the maintenance, pooling licenses does not make a noticeable difference, only saving the county as a whole $1000. In addition, some agencies actually pay more than they would have for non-pooled licenses under this scenario. See Table D.8 for details.

8.5.4 Summary

The table below is a summary of Tables D.5 through D.8, and a comparison of costs. Pooling costs are based on a single common license server, and the assumption is being made that all ArcView licenses will be converted. While the latter will almost assuredly not be the case, it is helpful to present the worst-case scenario.

Summary: ArcView Conversion Cost

Agency	Number of ArcView 3.x Licenses	Cost to Convert to Standalone	Cost to Convert to Concurrent	Existing ArcView 8.x Licenses *	Annual Maintenance after Upgrade (all licenses, non-pooled)	Annual Maintenance after Upgrade (all licenses, pooled) **	Pooling Difference **
Budget	1	600	2080		700	521	179
KCA	22	13200	45760		11400	11456	-56
DDES	20	12000	41600		10400	10414	-14
PubHealth	8	4800	16640		4200	4166	34
FMD	2	1200	4160		1200	1041	159
OEM	3	1800	6240		1700	1562	138
REALS	5	3000	10400		2700	2604	96
GISC	20	12000	41600	10	15600	15622	-22
Parks	6	3600	12480		3200	3124	76
SWD	2	1200	4160		1200	1041	159
WTD	5	3000	10400		2700	2604	96
WLRD	59	35400	122720	15	38400	38533	-133
KCIA	0	0	0		0	0	0
Roads	35	21000	72800		18300	18225	75
Transit	27	16200	56160	5	16600	16663	-63
Sheriff	4	2400	8320		2200	2083	117
Council	2	1200	4160		1200	1041	159
Totals	221	132600	459680	30	131700	130700	1000

* This and subsequent columns do not include the four standalone ArcView 8.x licenses located at Budget (1), KCA (1), and KCIA (2).

** Rounded to the nearest dollar.

Since there is such a large difference in the cost to upgrading ArcView to standalone and converting to concurrent-use licenses ($600 versus $2080, respectively), agencies should

carefully consider whether the benefits of concurrent-use licensing are worth the additional cost. Low use agencies, or those with many licenses to convert may find it more cost effective in the short and long-term to convert some or all of their licenses to standalone. However, if this strategy is adopted, care must be taken when choosing the initial version to lock into.

8.6. Extensions

8.6.1 Current Cost

Current cost for all ArcView 3.x extensions is zero.

ArcInfo extensions, however, incur annual maintenance. Four agencies currently maintain 16 COGO licenses, at a total annual cost of $4700 (see Table D.9). In addition, GISC maintains one TIN 7.x license, and DDES and GISC each maintain one GRID 7.x license. Roads maintains one Network 7.x license, while Transit and GISC each maintain two.

8.6.2 Conversion

Extensions are upgradeable one-to-one. There is no cost to upgrade Arc/Info extensions under maintenance; however, there is a cost to upgrade ArcView 3.x extensions. Annual maintenance costs will not change unless standalone licenses are converted to concurrent-use.

With the exception of COGO, extensions have the same basic functionality in ArcGIS that they do in Arc/Info or ArcView.

It should be noted that extension licenses cannot be swapped without additional cost. For example, an agency that no longer needs its 3D Analyst license cannot turn it into a Spatial Analyst license without paying a fee. Therefore, agencies should conduct an internal assessment to determine the use and need for their extensions, and whether they wish to drop maintenance on certain ones or purchase others.

8.6.2.1 COGO

ArcInfo 8.3 incorporates much of the functionality formerly found in the COGO 7.x extension (COGO is not available for ArcView 3.x). While it is anticipated that the additional functionality offered in Survey Analyst will not be needed, it would nevertheless be desirable to keep the single existing enterprise floating Survey Analyst 8.x license available for use.

Dropping maintenance on the 16 existing Arc/Info 7.x COGO licenses will result in a savings of $4700. Unfortunately, the maintenance on the dropped COGO licenses cannot be transferred directly to other extensions or core licenses. See Table D.9 for details.

8.6.2.2 Spatial Analyst

The cost to upgrade Spatial Analyst is the same whether upgrading to standalone or concurrent-use; the only real issue is whether to upgrade to concurrent-use licenses and thus incur the mandatory yearly maintenance fee.

Nine agencies have a total of 18 Spatial Analyst licenses for ArcView 3.x: Budget (1), KCA (1), DDES (1), OEM (1), GISC (3), WLRD (3), WTD (1), Roads (3), and Sheriff (4). In addition to their Spatial Analyst 3.x licenses, Roads and WLRD have one 8.x license each for which they are already paying Primary maintenance, and GISC has one GRID 7.x license under maintenance. Table D.10a shows details and includes only costs to convert ArcView 3.x licenses.

Cost to convert: $10,800
Additional annual maintenance (if all licenses become concurrent-use): $6,300

8.6.2.3 3D Analyst

The cost to upgrade 3D Analyst is the same whether upgrading to standalone or concurrent-use; the only real issue is whether to upgrade to concurrent-use licenses and thus incur the mandatory yearly maintenance fee.

Four agencies have a total of five 3D Analyst licenses for ArcView 3.x: PubHealth (1), GISC (1), WTD (1), and Roads (2). In addition, Roads, WLRD, and Transit each have one 8.x license for which they are already paying Primary maintenance, and GISC has one TIN 7.x license under maintenance. Table D.11a shows details and includes only costs to convert ArcView 3.x licenses.

Cost to Convert: $3,000
Additional annual maintenance (if all licenses become concurrent-use): $2,200

8.6.2.4 Network Analyst

Network Analyst will not be available until ArcGIS 9.0. However, it can be expected that licensing and upgrade costs will follow past practice, so that upgrading Network Analyst will be the same whether upgrading to standalone or concurrent-use. If this is the case, then the only real issue will be whether to upgrade to concurrent-use licenses and thus incur the mandatory yearly maintenance fee.

Figures and analysis are based on current pricing.

Two agencies have a total of three Network Analyst licenses for ArcView 3.x: GISC (2), and Roads (1). In addition, GISC has one and Transit has two licenses for Arc/Info 7.x that can be upgraded at no cost. GISC and Transit also each have one existing license for ArcGIS 8.x under maintenance, awaiting the software. Table D.12a shows details and includes only costs to convert ArcView 3.x licenses.

Cost to convert: $1,800
Additional annual maintenance (if all licenses become concurrent-use): $1,200

8.6.2.5 ArcPress

The cost to upgrade ArcPress for ArcView 3.x to a concurrent-use ArcGIS license is ten times that to upgrade to standalone. Thus, the consideration here is not only that of annual maintenance, but conversion cost.

Six agencies have a total of ten ArcPress licenses for ArcView 3.x: DDES (1), REALS (1), GISC (2), WTD (1), WLRD (1), and Roads (4). In addition, Roads has an additional ArcPress license for ArcGIS 8.x for which they are already paying Primary maintenance. Table D.13 has details.

Cost to convert to single use: $1000

Cost to convert to concurrent-use use: $10,000
Annual maintenance on concurrent-use licenses: $2000

8.6.2.6 Pooling Extension Licenses

While it is not possible to pool all extension licenses into one large pot, it is possible to pool individual extensions. The same discussion and caveats that apply to core software also apply here, with a few exceptions.

ArcPress has only one maintenance fee for all licenses instead of Primary and Secondary maintenance – therefore, pooling ArcPress licenses does not save money, although the argument for centralized license management may still apply, especially if it is implemented for the other extensions.

Also, it should be noted again that as of publication, Network Analyst for ArcGIS has not been released; therefore, the numbers listed below and in other tables are estimates based on past practice.

If licenses for Spatial Analyst, 3D Analyst, and Network Analyst were each pooled on a single server, the county could save $3500.

See Tables D.10b, D.11b, and D.12b for details, including costs to individual agencies.

8.6.3 Summary

The table below is a summary of Tables D.10 through D.13, and a comparison of costs. Pooling costs are based on a single common license server, and the assumption is being made that all licenses for ArcView extensions will be converted. Not included in the table below are COGO 7.x licenses, which are not likely to be upgraded.

While the cost differences for conversion and maintenance for extensions are not as great as those pertaining to ArcView, and there are not as many licenses to consider, it would still be wise to do at least a cursory inspection of license use for extensions. However, it is likely that the number of extension licenses that can be dropped will be proportionally smaller than for ArcView in large part because extensions are almost entirely used by analysts rather than end users.

Summary: Extension Conversion Cost

Extension	Number of ArcView 3.x Licenses	Cost to Convert to Standalone	Cost to Upgrade to Concurrent	Annual Maintenance after Upgrade (all licenses, non-pooled)	Annual Maintenance after Upgrade (pooled)	Savings by Pooling

Spatial Analyst	18	10800	10800	6500	3900	2600
3D Analyst	5	3000	3000	3600	2100	1500
Network Analyst	3	1800	1800	2500	1900	450
ArcPress	10	1000	10000	2000	2000	0
Totals	36	16600	25600	14600	9900	4550

8.7. Summary

Costs are listed where appropriate. The only first-year maintenance cost is associated with ArcInfo, as those licenses are already under a maintenance agreement (the number listed is for non-pooled management).

	Current Maintenance costs	First-Year costs		Second-Year Maintenance Costs	
		Conversion	Maintenance	Not Pooled	Pooled
ArcInfo	57570	0	67240	67240	61180
ArcView to Standalone		132600	0	0	
ArcView to Concurrent		459680	0	131700	130700
Extensions to Standalone		15600		0	
Extensions to Concurrent		15600		8800	6427
ArcPress to Standalone		1000			
ArcPress to Concurrent		10000		2000	2000
COGO	4700	-4700			

8.8. Conclusions and Recommendations

8.8.1 License pooling

It is highly recommended that the GIS Technical Committee create a subcommittee to see if they can get past budgetary, technical, and political obstacles to determine if fully implementing license pooling is feasible. If they determine that license pooling is feasible and desirable, then they will need to:

- determine how many licenses will actually be needed based on acrual use;
- determine how the funds will be transferred among agencies and to ESRI;
- deal with potential technical issues involving access to the license server from remote sites; and
- determine how best to ensure that agencies have access to the number of licenses for which they are paying.

8.8.2 Upgrading options

As mentioned earlier, there are many scenarios for upgrading the different types of licenses. Agencies will need to audit their own use to determine how many licenses to upgrade and when,

and then they will need to coordinate to determine how to best pursue the decisions of concurrent-use versus standalone licensing and the possibility of pooling.

The GIS Technical Committee should facilitate coordination among agencies where needed, especially in the matter of determining the best options to reduce cost where possible.

8.8.3 The possibility of ArcEditor

It may be feasible for certain steward agencies to forego their ArcInfo license and downgrade to ArcEditor, depending on their maintenance needs. In particular, agencies with light maintenance needs and agencies currently holding many Arc/Info licenses should make the effort to determine whether such a downgrade is feasible.

8.8.4 Timing of License conversions

Since each GIS agency is autonomous with respect to its licensing and use, a coordinated effort will be needed to ensure the smooth transition of Arc/Info and ArcView licenses to ArcGIS counterparts. In addition, license upgrades will need to be coordinated with the overall transition to ArcGIS use for layer editing (production) and access (data warehouse).

ArcView 3.x: While there are no technical obstacles to beginning the immediate conversion of ArcView licenses for end users, it would be wise to use the implementation of the read-only SQL Server SDE data warehouse and its accompanying access tools (which will replace AVLib and Parcel Tools) as the major target for beginning the conversion of ArcView licenses.

Agencies should take into consideration not only users' use and needs for GIS software, but the time and effort that will be involved in recreating existing, recent, and/or archived ArcView 3.x projects to ArcGIS. In particular, if an agency chooses not to recreate all ArcView 3.x projects to ArcGIS, then at least one ArcView 3.x license will need to be maintained in order to access these projects if needed.

Agencies and the Migration Workgroup should also strive to move as many users as possible onto other mechanisms for serving data, such as ArcIMS. This could obviate much of the need for expensive license upgrades.

There is also an understanding that there will be a segment of the user population which will not ever completely discard ArcView 3.x. (see section 5.3.5). These users will be considered "legacy" ArcView users. The Migration Workgroup will need to determine the extent of this group of users, and how they will accommodated.

Arc/Info: The full implementation of the new geodatabase design, including editing processes, will be the determining factor for the timing of the conversion of Arc/Info 7.x licenses to ArcInfo 8.x. Given that the cadastral base will be the last spatial data converted to geodatabase, it is almost certain that the cadastral update team at KCA and the KCGIS Center will be the last users of Arc/Info 7.x. Only when all parties involved are satisfied that the cadastral base is functioning as it should within the SDE geodatabase, and it is verified that no other agency is using Arc/Info 7.x for editing, should the last of the Arc/Info 7.x licenses be converted. Final deadlines and dates will need to be determined as part of the Cadastral Conversion Plan.

Extensions: Extensions should be upgraded at the same time that ArcView is upgraded, or at need. Again, it would be wise to inventory use of existing licenses to determine need for upgrading, and the Technical Committee's ArcView deadline should apply to extensions as well.

COGO licenses on the enterprise server *WILDFIRE* should be maintained until KCA has completely converted to ArcGIS for editing the cadastral base, at which time maintenance on these licenses should be dropped. The exiting floating Survey Analyst license on the enterprise server *ORCA* should be kept for those presumably rare instances in which a user needs the additional functionality that it offers.

9 Training

When the world of GIS consisted of Arc/Info and ArcView 3.x, it was a relatively simple matter to decide which software was the correct fit for a given individual, then choose from the limited number of training options available. But as GIS has become more complex, user needs have become more diverse, and training options have multiplied. We can no longer assume "one size fits all" as we did in the past.

Unfortunately, as needs and options have increased, agency training budgets have become more limited. Traditional classroom training is relatively expensive, and when we consider that the new version of GIS software will require some level of training for *every* GIS user in the county, it becomes obvious that providing ESRI-certified classroom training for everyone is cost-prohibitive.

To meet the needs of King County GIS users, the KCGIS Center is in the process of formulating a training plan, which will be in place by 2005. A cornerstone of the training plan is the notion of modularizing. Instead of creating one or two long courses, KG GIS Center will instead offer several independent modules that can be mixed and matched based on user needs.

The training plan and implementation consist of the following components:

- Categorizing GIS users in the county
- Developing an appropriate training curriculum for each category of users
- Determining the appropriate timeline for completing training

9.1. GIS user categories

9.1.1 Rationalization

By grouping county personnel into relatively broad categories based on their GIS needs and use, we can assign desktop setups, software installations, and training curriculum. In general, the categories are listed from the least to the most technically demanding.

9.1.2 User Categories

User categories and definitions are as follows. It should be noted that any given individual may fit into more than one category; if that is the case, then they should be placed in the most technically demanding category in order to ensure that their hardware, software, and training needs are fully met.

Data User: These are end-users, who are concerned with querying, viewing and creating hardcopy output of GIS maps and associated information. Data Users do not create or modify data. While they may use GIS heavily in their day-to-day work, their primary job description is not GIS-oriented.

Data Analyst: Analysts can be either GIS professionals or end-users. Like the Data Users, they also query, view and create hardcopy output using GIS resources. However, they tend to employ

more sophisticated GIS methods than Data Users, and create more complex and technically demanding maps. They likely create and maintain GIS data for project-level use, but generally do not create and maintain enterprise data. Analysts may or may not provide support to other GIS users.

Data Maintainer (Steward): Maintainers are GIS professionals who are usually analysts, but are also stewards of enterprise data. They deal with issues of conversion, quality assurance and control, and metadata. Data maintainers likely provide support to other GIS users.

Developer: These are GIS professionals who are responsible for the development of GIS scripts and applications. Developers likely provide support to other GIS users.

Decision-maker: While decision-makers may exist in any of the other groups, this category is for those who have little or no experience with GIS, but must still deal with GIS issues. Decision-makers may be supervisors or managers who have GIS personnel working for them, or they may be project managers whose projects have a GIS component.

Database Administrators / System Administrators: DBAs and System Admin. personnel may or may not be familiar with GIS concepts and software functionality, yet have a need to deal with GIS issues, specifically those pertaining to the geodatabase.

9.1.3 Identification and categorization of users

Identification of GIS users and their placement into the appropriate category must occur at the agency level – GIS managers will need to identify GIS professionals and end-users in their own agency. For agencies that do not have GIS staff, the KCGIS Center will need to take the lead.

GIS users will need to be evaluated on an individual basis to determine their use and needs for GIS. This is especially true for more casual users, who may be able to eschew ArcGIS completely in favor of more thin-client applications such as ArcIMS.

It may be helpful to create a "survey template" that agencies can use as a guide to identifying and categorizing their GIS users. The following are a sample of the types of questions that may be helpful:

- How often does the person access GIS?
- What software does the person use?
- What specific activities does the user engage in?
  - data query and viewing
    - "quick lookup" of facts and spatial information
    - property research
    - analysis using a GIS or GIS-enabled application (e.g., iMAP, internal Transit applications)
  - vector analysis
    - buffering
    - geocoding
    - spatial overlay
  - image analysis

- map making:
  - "single-use" – i.e., a nonpublished presentation
  - public meetings, etc.
  - publication in technical documents
  - self-contained cartographic publication
- data creation and maintenance
  - "one-shot" or ongoing project data
  - maintenance of enterprise data layers
- programming
  - scripting for personal efficiency
  - scripts/programs/applications for others

9.2. Training options

To provide the most appropriate training for each GIS user, a number of options will be provided. Users should find that a combination of choices from the options will meet their training needs.

9.2.1 ESRI Instructor-led training

ESRI has developed a comprehensive curriculum of instructor-led classroom courses that are offered in many locations, including Olympia and Seattle. Most, if not all, of the classes offered in Seattle are located in King County facilities.

These classes cost an average of $400 to $475 for each day of the course. Many of the classes offered in county facilities include one or two free seats for county employees. ESRI also offers "on-site" classes, where an ESRI instructor comes onsite to teach a standard class for a flat fee. This type of training is an attractive option when many county users need to take the same class at the same time, as it can result in a significant cost savings.

ESRI adds courses to their curriculum on a regular basis; below is a sample of standard (and current) classes that may be of interest to county GIS users.

Course Title	Length	Description
ArcGIS 8.3		
Introduction to ArcGIS I	2 days	Intro course for those who are new to GIS. It includes basic concepts elements of GIS and how they are implemented in the ArcGIS software
Introduction to ArcGIS II	3 days	Continuation of Intro to ArcGIS I with expanded content and more advanced topics.
Migrating from ArcView 3.x to ArcView 8	2 days	Designed for ArcView 3.x users. This class is similar to Intro to ArcGIS I, with less emphasis on the basics of GIS and more on migrating ArcView 3.x projects into ArcGIS.
What's New in ArcGIS 8.3	3 days	An advanced class for experienced GIS users who already understand the concepts of ArcGIS, but need to know specific capabilities of ArcGIS 8.3.

Geodatabase Design Concepts	2 days	Designed for GIS data modelers, database designers, and analysts. A more theoretical course that deals with the steps in planning and designing a geodatabase and has a heavy emphasis on Unified Modeling Language (UML).
Building Geodatabases I and II	2 days / 3 days	An advanced class for data managers – how to create geodatabases, load data, define topology rules.
ArcIMS		
Introduction to ArcIMS	3 days	Intro course for ArcIMS. How to install, build, utilize, and customize internet mapping applications.
Customizing ArcIMS with ArcXML	2 days	Designed for experienced ArcIMS developers. Teaches advanced methods for using ArcXML to improve web delivery systems.
Customizing ArcIMS Using HTML and JavaScript	3 days	Designed for experienced ArcIMS users and HTML/JavaScript Web developers. Teaches how to use Dynamic HTML to create interactive maps and communicate with ArcIMS servers using ArcXML.
Customizing ArcIMS using the Active X Connector	3 days	Advanced course that deals with Active Server Pages (ASP) techniques, the ActiveX connector, and ActiveX Data Objects (ADO).
ArcIMS Administration	2 days	For ArcIMS server administrators. Deals with security, performance, authentication, optimization and troubleshooting issues.
ArcSDE		
Introduction to ArcSDE using ArcInfo 8	2 days	Introductory SDE course that overviews SDE architecture, storage, functionality and basic administration. Not necessary if any other SDE class is taken.
ArcSDE Administration for Oracle / SQL Server	2 days each	Designed for Oracle or SQL Server administrators respectively. Includes installation, configuration, data loading, database tuning and optimizing for the respective database platforms.
Programming		
Introduction to Programming ArcObjects with VBA	5 days	For experienced ArcGIS users who may be new to programming or the Visual Basic environment. Includes interface customization, ArcObjects classes and help resources.
Advanced ArcObjects Component Development I	3 days	Advanced programming course. Details how to use Visual Basic, COM, and ArcObjects to build custom components that extend the functionality of ArcGIS.
Advanced ArcObjects Component Development I (C++ and .NET versions available)	3 days each	Continuation of Advanced ArcObjects Component Development I using either C++ or C# in the .NET environment, respectively.

9.2.2 KCGIS Instructor-led training (Authorized Teaching Program)

KCGIS instructors are authorized to teach the following courses on site. Cost for these courses has historically held around $300 for each class. Descriptions can be found in the table above.

- Migrating from ArcView 3.x to ArcView 8
- Introduction to ArcGIS I
- ArcView 3.x – This is the introductory course for ArcView, which is not included in the above list.

9.2.3 ESRI Online courses (ESRI Virtual Campus)

ESRI offers a wide variety of online courses at their Virtual Campus. The content includes much of that which is found in their standard instructor-led courses. Costs range from free to about $125 for ESRI-authored courses, and are a good choice for the motivated, self-directed user. Many of the fee-based core courses still offer the first module for free, so that users can decide whether online learning is appropriate for them.

The Virtual Campus is subscription-based – that is, agencies can "pre-purchase" a certain dollar amount of training, then individuals are given access to specific online courses by the subscription administrator (the agency contact person with administrative rights to the account). ESRI offers volume discounts at an increasing rate of "pre-purchase," so it would save the county money to pool their resources for Virtual Training.

One drawback to using the ESRI Virtual Campus for technical training is that GIS software must already be installed on the user's machine. If this becomes an issue, a possible workaround is to make a machine available at the GIS Center that has GIS software loaded, and that can be scheduled for use for those taking Virtual Training.

Course titles of interest pertaining to county migration are listed below. Note that the offerings of Virtual Campus courses tend to be more dynamic in nature; for current information, refer to ESRI's website.

ArcGIS and its extensions:

- ArcGIS Annotation: Tips and Tricks
- Basics of the Geodatabase Data Model
- Creating and Editing Geodatabase Features (for ArcEditor and ArcInfo)
- Creating and Editing Geodatabase Topology (for ArcEditor and ArcInfo)
- Creating and Editing Linearly Referenced Features (for ArcEditor and ArcInfo)
- Creating, Editing, and Managing Geodatabases for ArcGIS 8.2
- Creating, Editing, and Managing Geodatabases for ArcGIS 8.3
- Customizing ArcMap: Easy Ways to Extend the Interface
- Editing Spatial Data in ArcMap: Tips and Tricks
- Getting Started with Surface Analysis Using ArcGIS Spatial Analyst
- Introduction to ArcGIS Survey Analyst
- Introduction to Geodatabases for ArcGIS (for ArcGIS 8.3)
- Labeling in ArcMap: Tips and Tricks
- Learning ArcGIS I (for ArcView 8, ArcEditor 8, and ArcInfo 8)

- Learning ArcGIS II: Presenting Information (for ArcView 8, ArcEditor 8, and ArcInfo)
- Learning ArcGIS 3D Analyst
- Learning ArcGIS Spatial Analyst
- Migrating Coverages into the Geodatabase
- Migrating from ArcView 3.x to ArcView 8
- The 15-Minute Map: Creating a Basic Map in ArcMap
- Understanding GIS Queries
- Using ArcCatalog: Tips and Tricks
- What's New in ArcGIS 8.3
- Working with CAD Drawings in ArcGIS
- Working with Geodatabase Subtypes and Domains (for ArcEditor and ArcInfo)
- Working with Rasters in ArcGIS
- Working with Survey Data in ArcGIS

ArcIMS:

- Customizing ArcIMS 4
- Learning ArcIMS 4

ArcSDE:

- Storing Raster Data in an ArcSDE Geodatabase (for ArcEditor and ArcInfo)
- Understanding ArcSDE Table Relationships
- Understanding the ArcSDE Spatial Index

Visual Basic and Visual Basic for Applications

- Introduction to Visual Basic
- Exploring the VBA Environment
- Working with Variables and Functions in VBA
- Working with Forms in VBA
- Understanding Branching and Looping in VBA

9.2.4 KCGIS Custom Courses

KCGIS custom courses have been developed and are taught by King County GIS personnel. These courses are geared to helping all users of King County GIS data and applications – both county employees and those from other agencies – become more informed, more efficient, and thus more productive.

Courses are modular in nature; that is, they can either stand alone or be combined to present a more comprehensive survey of KCGIS data and applications. Many of the courses, especially the one-hour modules are designed to be low- or no-cost.

It should be noted that the potential and planned courses may and likely will change scope as user needs are further refined.

9.2.4.1 Half- and one-day courses

Course Title	Status	Description
Putting King County GIS to Work (ArcView 3.x)	existing	Designed as an extension to ESRI's Introduction to ArcView course, although no prior GIS or ArcView knowledge is required. Deals with accessing and using King County GIS and Assessor's data with ArcView 3.x.
Using King County Assessor's Data	existing	Designed to support any organization that currently uses ArcView 3.x or ArcGIS with King County Parcel data.
Putting King County GIS to Work with ArcGIS	planned	Designed to be an extension to ESRI's Introduction to ArcGIS I. Will deal with accessing and using King County GIS and Assessor's data with ArcGIS.
GIS for Managers: An executive Summary (1/2 day course)	potential	Using GIS to effectively meet business needs.

9.2.4.2 One-hour seminars

Course Title	Status	Description
Using AVLib – Implementing King County Cartographic Standards	existing	Focuses on using GIS data and metadata, using the ArcView 3.x Public Library extension (known as "AVLib").
Using iMAP	existing	Introduces the interactive, web-based application iMAP, which offers query and map-creation functions for a wide variety of King County GIS layers and imagery.
Using Parcel Tools	existing	Introduces the ArcView 3.x Parcel Tools extension, which offers query and map-creation functionality for the county Parcel layer and associated Assessor's information.
King County ECC GIS Volunteer Training	existing	How to man the GIS station during activations of the Emergency Communications Center (formerly the EOC).
Web-based Property Research	potential	Participants learn to use the standard and enhanced modes of Parcel Viewer to perform property research. Also includes other online county resources for researching property information.
What Is GIS?	potential	For anyone interested in an overview of how GIS tools, resources and techniques can meet their business needs. Offers a brief overview of industry trends as a whole and their local impact.
Using the Art and Science of Cartography with King County	potential	Cartographic theory, techniques, and resources applied to King County GIS data. How to present

GIS Data		spatial data in the most effective manner.
Making Sense of the Census: Putting Census Data to Work in King County	potential	Designed to help ArcView 3.x and ArcGIS users make effective use of the King County 2000 Census data. Reviews census geography and tabular data needed to perform basic analysis.
Using King County Imagery	potential	Accessing and using county-owned imagery. This course will also cover imagery types and formats, and which is the best imagery to use for a number of common scenarios.
Mining the Web for GIS Resources	potential	An overview of web-based GIS resources that are of interest to people in the Puget Sound region.

9.2.5 Other learning opportunities

KCGIS Users Group: Held monthly, the KCGIS Users Group offers presentations by peers, ESRI representatives, and occasionally other parties and vendors. This is a forum that allows county GIS users to gather and disseminate technical information as well as expand one another's GIS horizons.

Conference and regional seminars: Local and national conferences offer an excellent opportunity to attend workshops and seminars on a wide variety of topics, as well as experience cutting-edge GIS technology before it is widely released.

GIS Day: GIS day activities and King County are designed to show GIS users and non-users the range and possibilities of GIS, and showcase work done by county agencies and employees.

9.3. Developing training plans for individual GIS users

9.3.1 Developing curriculum plans for the user categories

An important aspect of the countywide GIS Training Plan will be to assign curriculum tracks for each of the GIS user categories defined above. These paths will guide GIS users through a series of courses in a logical order to support them in their business function. The expectation will not be that users will immediately sign up for and take all the recommended courses at once, but instead space them over time and take them to the best advantage of both business needs and budgetary constraints.

Curriculum plans will need to incorporate some measure of flexibility so that agencies and individual users can tailor their training to their business needs. Plans will also need to be in a logical time order, and offer optional tracks and courses where such is appropriate.

The work of developing curriculum plans must take place at the inter-agency level to ensure that the tracks that are developed meet as wide a range of needs as possible.

9.3.2 Deciding how individual users move through their curriculum plan

The curriculum plan is not meant to be inflexible or pedantic, but rather a set of recommended guidelines. Some courses will be highly recommended; others will be listed as optional.

The decision on how individual users move through the curriculum track assigned to them is up to the users and their supervisors, based on both the business needs of the agency, and the career desires of the user.

9.3.3 Timelines: coordinating with software upgrades

In some sense, timing of training for new software can be based on individual need. Some experienced ArcView users will be more comfortable playing around with ArcGIS for a short time before they take the "Migrating from ArcView" class, while others will want to take the training before the software is even installed on their machine. These decisions will need to be made by the user and his/her supervisor.

However, it is imperative that ArcGIS training be timely. Users run a substantial risk of losing the knowledge and skills that they've acquired if they are not offered the opportunity to use them very soon after training. And if training is put off, its value diminishes as the user becomes more accustomed to the software.

Despite the fact that it is integrated with Windows architecture, ArcGIS can have a relatively steep learning curve, especially for long-time ArcView and command-line Arc/Info users. Therefore it will likely be necessary to just accept the fact that that there will be a decrease in production as users get accustomed to new functionalities and new methods of doing their work.

The countywide training plan will not be fully developed and implemented until 2005, while the software migration is slated to start in 2004. One of the first tasks will be categorize the users so that specific timelines and upgrade paths can be developed. Therefore, it is highly unlikely that the curriculum tracks that are developed will be fully realizable during the migration. However, the major KCGIS-developed courses having to do with basic data access are already in place. These, coupled with instructor-led and online courses should suffice to get the vast majority of GIS users up to speed with the new software in a timely manner.

9.3.4 Costs

It is not reasonable to expect that every current ArcView user will want or need to take the ESRI-led "Migrating from ArcView." However, it is reasonable that most Analysts and Developers will need to take at least one classroom-based class, as these offer information that cannot be found elsewhere.

A number of core ArcGIS classes are offered online, at considerable discount (at least one, "Migrating from ArcView 3.x to ArcView 8," is offered free). The caveat here is that these courses are developed by two different sections of ESRI Training, so while the content can be assumed to be similar, the online courses will not directly relate to the instructor-led classes. In addition, the online courses do not offer "take-home" materials for future reference.

One goal of the countywide Training Plan is to manage costs of the various modules so that they can be offered at low or no cost to county employees.

9.4. Recommendations

9.4.1 Developing the curricula

The Migration Workgroup and the GIS Training Coordinator should develop training curriculum plans for the GIS user categories. This work will be part of the development of the countywide Training Plan.

Choose courses for the curricula based on the needs of users in that category, but be aware of cost. Where at all possible, recommend KCGIS-developed classes and Virtual Campus courses over ESRI instructor-led courses.

Offer optional courses and branches, especially with the King County modules, since these are tailored to county data and users and are of minimal cost.

It might be useful to create one or more specialized tracks to be offered as adjunct training. One example is a "Parcel Track," which incorporates appropriate courses from the Virtual Campus and KCGIS modules.

9.4.2 Recommendations for standard curricula

Every new GIS hire should take "Putting King County GIS to Work," and be introduces to KC GIS Best Practices and Cartographic Standards.

Every Analyst and Developer should take the online course of ESRI's "What's New with ArcGIS X.X" for every major software upgrade.

Anyone who makes more than one map a year, or develops applications that create maps, should take "Using the Art and Science of Cartography with King County GIS Data."

"Web-based Property Research" should be an optional course for every curriculum.

9.4.3 Categorizing the users

Develop a survey template to act as a guide in placing county GIS users into the appropriate categories.

Agency GIS managers or their designees will categorize the GIS users within their agencies. The KCGIS Center will take the lead on categorizing users in the rest of the county. Categorization should be relatively liberal – that is, a user who can fit into multiple categories should always be placed in the more technically demanding category to ensure complete and appropriate software installation, as well as proper training.

Users should take the recommended courses, but should be allowed flexibility within the curriculum to best meet business needs. Users should be encouraged to take optional KCGIS modules.

9.4.4 Other recommendations

Look into the possibility of pooling agency training resources for Virtual Training.

Training needs to be integrated within each agency's migration timeline, so that users retain the knowledge that they gain and are able to put it to use at once. Therefore, core training courses that are offered in the next two to three years need to be highly synchronized with user upgrade timelines.

10 Communication

Because of the distributed nature of GIS in King County, the large number of users, and the large quantity of data involved, good communication will be an essential component of a successful migration. Not only will the KCGIS Center need to communicate widely and frequently, but also agencies will need to keep the greater enterprise apprised of their timelines, challenges and status.

It is unrealistic to assume that a software migration of this scope and complexity will be implemented without problems. The KCGIS Center and "early adopter" agencies will be relied upon to provide valuable information regarding their challenges, so that others can avoid their mistakes, software "gotchas," and implementation dead ends.

It will be of vital importance that the Technical Committee and the Migration Workgroup take the lead role in keeping the lines of communication open, not only among themselves as representatives of GIS agencies in the county, but also within their own agencies to keep their GIS staff and end-users informed.

10.1. Communicating the plan to agencies, staff and users

The GIS Software Migration Plan should be published to both the external KCGIS website (www.metrokc.gov/gis), and to an appropriate location in the internal Public Folders.

10.2. Tracking agency and enterprise overall status

Without a mechanism to track agency and enterprise migration status, there is no way to know how the overall migration is progressing.

The most straightforward method is to create a list for each agency and the KCGIS Center, and post updates regularly. The list will include the major task points listed in the migration plan, target dates of completion, and status. Primary responsibility for each agency should be that agency's Technical Committee representative (or a designee).

The status lists can be posted on the internal KCGIS website for viewing and possibly updating. Regular status reports should be made to both the Technical Committee and the KCGIS Users Group.

10.3. Communicating changes to data

Once the data review and optimization process gets underway, there will be a strong need to keep data stakeholders informed. KCGIS Best Practices outlines processes for conversion to new data models and communicating changes to data:

Conversion to new data models

Definition: Successful conversion of spatial or tabular data from one format to another involves a well-formulated plan. The purpose of a data conversion plan is to lessen the potential negative effects and increase the potential positive effects that data conversions might have on projects and processes.

Goal: Any conversion of production data should include a conversion plan.

Best Practices:

1. When data conversions are proposed that will affect data stored for use by a work group of any size (as opposed to data stored and/or converted for use by a single individual), a data conversion plan should be created through a collaborative process with all affected parties. The data conversion plan should evaluate the current data format and data warehousing structure, the proposed data format and data warehousing structure, a step-wise description of the proposed process of conversion, and any impacts on applications and operations that the conversion will have, along with proposed remedies for the identified impacts. Section 2, Best Practices for Communication of Events.
2. Data conversion plans are documents which evaluate the current data format and data warehousing structure, the proposed data format and data warehousing structure, the proposed process of conversion, and any impacts on applications and operations that the conversion will have, along with proposed remedies for the identified impacts.
3. Document data conversions in as thorough a manner as possible.

Limitation: It is not necessary, though it may be advisable, to document conversions of data sets that are only to be used for one project and/or by one person.

In addition, that document's Appendix A (Communication Matrix) states that for the events of New Data Layer, Change to Data Layer, and Delete Data Layer, the proper communication channel is for the data steward to add to the weekly e-mail digest prior to the event, then make an announcement at the next KCGIS User Group. In addition, the KCGIS Center should post the event on the front page of the website in a timely manner.

As of January 2004, there are nearly 300 coverages in /plibrary that are maintained internally. While some of these are likely to be deleted in the preliminary review process, there will still be a large number of data layers left, each of which will be touched at some point during the data migration.

It will be necessary to employ as many mechanisms as technically feasible for notifying data stakeholders of impending changes. Possibilities include:

- E-mail digest: The weekly e-mail digest, which has not yet been implemented, will become a critical mechanism for notifying data stakeholders of impending changes. Stewards would e-mail the digest administrator, who would send one email per week to *ZZGrp, GIS Datanews*. Past digests can be archived in a Public Folder on the county's Exchange server for easy reference.

- Master list: A master list should be developed that lists every layer, its steward, and its current status. The list should exist in a central location, and be updated regularly and frequently. It can either be a low-tech solution such as an Excel spreadsheet with a single point-of-contact for updates. This will work best if the point-of-contact is the same as the digest administrator. A higher-tech solution would be to build an internal web application, which can offer stewards direct access to a database.

- KCGIS Center website: The home page of the KCGIS Center website can host an ongoing "Data migration" section, with links to the master list, and a explicit listing of layers that are "pending."

10.4. Technical documentation

Technical documentation that is specific to the software migration should be posted to the KCGIS Center Knowledge Base, and announced at User Group meetings as "Migration Tech Tips." As the source for most of this information will likely be those stewards, analysts, and developers implementing agency migrations, it is vitally important that they not only communicate with each other, but also be encouraged to write up short "how-to" tips when they come across a new situation or solve a problem. This will assist others who are coming behind them.

10.4.1 Documentation for migration implementers

This type of documentation should include (but is not limited to) the following:

- How to create and maintain data layers in a SDE geodatabase
- Data conversion methods
- Data optimization processes
- Technical tips, tricks, and "gotchas."

10.4.2 Documentation for end users

End users will need help from their GIS support staff to make the adjustment to the new software and data format. Many of the same questions will get asked, regardless of agency or business need. It will be important to offer easy-to-find, centralized help for end users and make its location widely known.

Topics can include:

- How to connect to GIS data
- How to figure out what data exists
- How to get information on the data migration
- Tips for being efficient with ArcMap
- How to perform simple tasks in ArcMap / ArcCatalog
- What training is available and how to get it
- Where to go for help

10.4.3 Other Documentation

KCGIS Center should publish on its website the following information:

- Which software version (ESRI and other) is currently being supported. If this is not the latest version, an estimated change date, if known, should be provided.
- Recommended desktop configuration for GIS users.
- List of enterprise applications, which version is current, and lifecycle status.

10.5. Post-mortem document – lessons learned

At some point after the migration is complete, a short post-mortem should be conducted. This should contain major problems encountered, major differences between the plan and the implementation, and lessons learned. The post-mortem should be published to the GIS website and the Technical Committee's Public Folders.

11 Migration Plan

11.1. Introduction

There are a number of fundamental assumptions that lie at the core of this plan. First and most important is the fact that KCGIS will be migrating to ArcGIS 8.3. While ESRI will almost certainly release version 9.0 before the county can complete its migration, we will not target that release for a number of reasons, which are outlined in Section 6.2.3.3. Additionally, we are migrating under the assumption that the next migration will also not be 9.0, but rather 9.2 or possibly later.

The second major assumption is that the protracted, phased nature of the software migration will necessitate parallel systems. Legacy systems will need to be maintained while new processes and structures are put into place. Ensuring that these new processes do not interfere with old ones will be the responsibility of the KCGIS Center and the Migration Workgroup. The following assumptions are in place:

- the shapefile library will remain in place indefinitely;
- the coverage library will eventually be retired;
- other processes, structures, and applications will remain in place until the need for them has been completely discontinued.

The third major assumption is the understanding that agencies cannot and will not attempt to migrate simultaneously. The widely disparate nature of business practices greatly impact GIS need, use, and resources across the agencies. Some of the larger agencies are already underway in their own migration, while other agencies do not intend to migrate until well after the enterprise migrates. Much of the effort of the migration will go toward making sure all agencies are well-supported during this transition period.

The final assumption is that while some of the goals and tasks must be performed sequentially, many others can be performed in parallel. It will be the responsibility of the Migration Workgroup and the Technical Committee to deal with specific prioritization and exact timelines of the parallel goals.

Finally, it should be understood that the phases, goals, tasks, and especially timelines are flexible. They should be considered malleable to best fit the needs and workloads of the agencies, Technical Committee, and the KCGIS Center. As long as good communication mechanisms are in place, the modification of goals, tasks and timelines should not be a cause for concern.

11.2. Phased Migration

This migration is to be phased in the sense that goals and tasks will be broken out into logical, time-oriented groups. We will not be phasing the migration in the sense that we will be setting up and working toward an eventual migration to ArcGIS 9.x. This is not feasible for a number of reasons, not the least of which is lack of available staff resources.

Details on the goals listed below, including specific tasks and timelines, can be found in the final sections, beginning with Section 11.5.

Phase 1: Preliminary tasks, needs assessment, design, training of key staff

Goal P1: Set Up the Migration Workgroup
Goal P2: Develop and Enable Communications Protocols
Goal P3: Categorization of Users
Goal P4: Preliminary Data Review
Goal P5: Investigate the Possibility of Outsourcing
Goal A1: Agency Technical Self-assessment
Goal A2: Agency Needs Analysis
Goal T1: Develop Training Curriculum
Goal T2: Develop Individual GIS Training Plans
Goal T3: Train GIS Stewards and Developers
Goal E1(Task 1, 2 only): Migrate enterprise front-end applications to ArcGIS format

Phase 2: Implementation of data warehouse, prototyping and testing of production warehouse and data migration, development of first-level enterprise applications, training of analysts

Goal A3: Create Agency Migration Plans
Goal D1: Implement SDE Geodatabase (GDB) Read-Only Warehouse
Goal D2: Migrate Externally-Obtained Data to the GDB Data Warehouse
Goal D3: Migrate Imagery to the GDB Data Warehouse
Goal D4: Create Data Design
Goal D5: Define Structure, Access, and Update Protocols for Production Server(s)
Goal D6: Implement and Test Prototype SDE Production Geodatabase
Goal D8: Ensure Access to Imagery
Goal T4: Train GIS Analysts, SysAdmins, and Decision Makers
Goal L1: Maximize cost efficiency of ArcGIS licensing
Goal L2: Determine need for additional short-term licenses while migrating
Goal E1 (all tasks but 1 and 2): Migrate enterprise front-end applications to ArcGIS format

Phase 3: Data migration, development of other enterprise applications and agency applications

Goal D7: Optimize and Migrate Internally-Maintained Data to the Production Geodatabase
Goal A4: Migrate agency-specific applications

Phase 4: Training and migration of end users

Goal T5: Train GIS Users
Goal E2: Support Legacy Applications while Migration is in Progress
Goal E3: Migrate Targeted ArcView 3.x Users to ArcIMS
Goal A5: Migrate Users

11.3. Milestones

The migration will be considered complete when the following conditions have been met:

- The primary data warehouse (except cadastral base) is the read-only SDE geodatabase. The shapefile library is maintained for "legacy" ArcView 3.x users. The coverage library no longer exists.
- Data editing and posting takes place in the SDE geodatabase environment.
- Enterprise applications are in place to facilitate data access, management, and editing where necessary. Agency-specific applications are migrated or their relevant functionality integrated into other business applications.
- End users have been categorized and trained, and have either migrated to ArcGIS, ArcIMS, or have been declared as a "legacy" ArcView 3.x users.

Milestones are in rough order; however, firm deadlines are not included because like goals and tasks, many of the milestones may be completed in parallel. Milestone tasks on this path include the following:

- Milestone Task #1: Goal T1 – Develop training curriculum.
- Milestone Task #2: Goal P4 – Complete preliminary data review.
- Milestone Task #3: Goal A3 – Create agency migration plans.
- Milestone Task #4: Goal D6 – Successfully implement prototype SDE production geodatabase.
- Milestone Task #5: Goal D7 – Optimize and migrate internally-maintained data to the production geodatabase.
- Milestone Task #6: Goal E1 – Migrate front-end enterprise applications for data access and management.
- Milestone Task #7: Goal A5 – Migrate users.

11.4. Definitions and conventions

11.4.1 Responsible parties:

- PM: Software Migration Project Manager
- Tech. Comm.: KCGIS Technical Committee
- Migr. Wkgp.: Migration Workgroup (see Goal P1 below)
- KCGIS Center: acting in enterprise capacity
- AppDev: KCGIS Applications Development Group
- Agency Leads: Individuals in agencies who will carry out agency-specific tasks. It is most likely that these will be members of the Migration Workgroup, but not necessarily.

11.4.2 Conventions used in the goal/tasks listing

- Deadlines are listed as time elapsed from acceptance of this document by the KCGIS Technical Committee. A "0" indicates that this task is complete at the publication of this document.
- In general, goals correspond to major recommendations made earlier in this document.

11.5. Preliminary tasks

Goal P1: Set Up the Migration Workgroup

Description: The Migration Workgroup (Migr. Wkgp.) consists of agency representatives who are considered technical leads, and technical representatives of the KCGIS Center. This group will be tasked with data modeling, determining agency needs, facilitating cross-agency coordination, ensuring (with the Technical Committee) that agency tasks are carried out in a timely basis, and other tasks as needed. It will be moderated by the Software Migration Project Manager, and will report to the GIS Technical Committee.

Task: **Create the Migration Workgroup**
Responsible Party: PM
Communication: Tech. Comm.; Migr. Wkgp., Agency Leads
Deadline: 0

Goal P2: Develop and Enable Communications Protocols

Description: Develop, publish, and enable communications protocols. Communication of task completions can be combined. See Section 10 for details.

Task: **Publish the Migration Plan to KCGIS website and Public Folders**
Responsible Party: PM
Communication: Tech. Comm.; GIS User Group; ZZGrp_GIS_All
Deadline: 2 weeks

Task: **Create and publish the Master Data List**
Responsible Party: PM
Communication: Tech. Comm.; GIS User Group; ZZGrp_GIS_All
Deadline: 2 weeks

Task: **Set up the e-mail digest for Data changes**
Responsible Party: PM
Communication: Tech. Comm.; GIS User Group; ZZGrp_GIS_DataNews
Deadline: 4 weeks

Task: **Set up the Software Migration section of the KCGIS website**
Responsible Party: KCGIS Center
Communication: Tech. Comm.; GIS User Group; ZZGrp_GIS_All
Deadline: 4-6 weeks

Task: **Set up the Master Migration Status Document**

Responsible Party: PM
Communication: Tech. Comm.; GIS User Group; ZZGrp_GIS_All
Deadline: 4 weeks

Goal P3: Categorization of Users

Description: Conduct a census of GIS users in King County Agencies. Assign each user into one of six "user categories" based on current and future GIS business need. See Section 9.1 for details.

Task: **Develop Classification guideline (survey template):**
Responsible Party: PM
Communication: Tech. Comm.; GIS User Group
Deadline: 2-4 weeks

Task: **Classification of GIS users**
Responsible Party: Agency Leads, assistance from KCGIS Center where needed
Communication:
Deadline: 8 weeks

Goal P4: Preliminary Data Review

Description: Conduct a fitness review of every internally-maintained coverage in the current GIS data warehouse (/plibrary). Layers that do not pass review should be archived and deleted immediately. See Section 7.4.1.1 for details.

Task: **Develop review criteria and procedures (including metadata standards)**
Responsible Party: Migr. Wkgp.
Communication: Notification of Technical Committee and Data Stewards when task complete. Publication of criteria and procedures to KCGIS website, ZZGrp_DataNews, GIS User Group and GIS AppDev Group.
Deadline: 2-4 weeks

Task: **Conduct preliminary data review using developed criteria and procedures**
Responsible Party: Migr. Wkgp.
Communication: Migr. Wkgp. should send status to PM. PM to keep Master Data List updated, and compile and distribute data changes to Data Digest and KCGIS website.
Deadline: 4-8 weeks

Goal P5: Investigate Possibility of Outsourcing

Description: It may be cost-effective to lessen the work load on enterprise and agency developers and analysts performing the migration work hiring others to do some of it. Methods could be either outsourcing, hiring term-limited employees, or some other solution.

Task: **Investigate the possibility of outsourcing migration work**
Responsible Party: Migr. Wkgp.

Communication: Tech. Comm
Deadline: undetermined

11.6. Agency Migration

Goal A1: Agency Technical Self-assessment

Description: Agencies will conduct an internal audit of their use and need for Arc/Info, ArcView 3.x and extensions. This goal can be completed in tandem with goal P3 and A2. See Section 8.3 (licensing) and Section 5.2.2 (hardware) for details.

Task: **Determine methodology for license audit – user poll or tracking software**
Responsible Party: Tech. Comm.
Communication: Agency Leads, KCGIS Center
Deadline: 4-6 weeks

Task: **Conduct Agency Internal Review of Arc/Info, and ArcView 3.x license needs**
Responsible Party: Agency Leads
Communication: Tech. Comm., Migr. Wkgp.
Deadline: 8-10 weeks

Task: **Conduct Agency Internal Review of existing hardware (servers and user workstations)**
Responsible Party: Agency Leads
Communication: Tech. Comm., KCGIS Center, Migr. Wkgp.
Deadline: 8-10 weeks

Task: **Determine need for agency-specific applications.**
Responsible Party: Migr. Wkgp.
Communication: Tech. Comm., KCGIS Center
Deadline: 12 weeks

Goal A2: Agency Needs Analysis

Description: Agencies will conduct a business needs analysis. This goal can be completed in tandem with goals P3 and A1. See Section 6 for details.

Task: **Determine issues that are barriers, impediments or merely concerns to a successful software migration at that particular agency;**
Responsible Party: Migr. Wkgp.
Communication: Tech. Comm., KCGIS Center
Deadline: 2 weeks

Task: **Determine what specific functionality each agency needs from ArcGIS**
Responsible Party: Migr. Wkgp.
Communication: Tech. Comm., KCGIS Center

Deadline: 2-4 weeks

Goal A3: Create Agency Migration Plans

Description: Categorize agency business and technical needs into functional groups and prioritize based on common needs. Use this information and that acquired from agency needs assessment, data design, and geodatabase design and implementation to create a migration plan for each agency. The level of detail included for each plan will need to be determined ahead of time. See Section 6.3 for more information.

There is no set task here for "implementing agency migration," since all plans will have common elements of data, applications, and users that are covered with other tasks and goals. Individual task lists and timelines however, will be highly variable and dependent on specific agencies.

Task: **Identify common needs across agencies, group needs by functionality, and prioritize.**
Responsible Party: Migr. Wkgp.
Communication: Tech. Comm., KCGIS Center
Deadline: 10 weeks

Task: **Create individual agency migration plans**
Responsible Party: Migr. Wkgp.
Communication: Tech. Comm., KCGIS Center, Agency Leads
Deadline: 12 weeks +

Goal A4: Migrate Agency-Specific Applications

Description: Need for migrating existing agency-specific applications will be determined through the agency needs assessment and migration plan process.

Task: **Migrate agency-specific applications**
Responsible Party: Agency Leads
Communication: Tech. Comm., KCGIS Center, Migr. Wkgp.
Deadline: flexible, depending on agency

Goal A5: Migrate Users

Description: For each user (or group of users, depending on the agency), determine the best migration path then implement.

Task: **Determine migration path for users based on category recommendations and agency needs**
Responsible Party: Agency Leads
Communication: Tech. Comm., KCGIS Center
Deadline: flexible, depending on agency

Task: **Ensure that users have standardized hardware and software (based on Migr. Wkgp. recommendations)**
Responsible Party: Agency Leads
Communication: Tech. Comm., KCGIS Center, Migr. Wkgp.

Deadline: flexible, depending on agency

Task: **Support users, either in new system or as legacy users**
Responsible Party: Agency Leads, KCGIS Center
Communication: Tech. Comm., KCGIS Center, Migr. Wkgp.
Deadline: flexible, depending on agency

11.7. Data

Data goals and tasks, especially those connected to the data design and the production database implementation will very likely change as the migration progresses. It is vital that changes are well-documented and communicated.

Goal D1: Implement SDE Geodatabase (GDB) Read-Only Warehouse

Description: Design, implement, and test the read-only SDE GDB data warehouse. Ensure that users can connect to the data. Devise and publish methodology and appropriate user-level guides. See Section 5.3.1 for details.

Task: **Design and implement GDB warehouse on SQL Server**
Responsible Party: KCGIS Center, AppDev Group
Communication: Migr. Wkgp; Tech. Comm.
Deadline: 8-12 weeks

Task: **Test GDB warehouse**
Responsible Party: KCGIS Center, AppDev Group
Communication: Migr. Wkgp; Tech. Comm.
Deadline: 8-12 weeks

Task: **Publish methodology and user guides**
Responsible Party: KCGIS Center, AppDev Group
Communication: Migr. Wkgp; Tech. Comm.
Deadline: 8-12 weeks +

Goal D2: Migrate Externally-Obtained Data to the GDB Data Warehouse

Description: Data obtained from external sources will be moved into the GDB data warehouse with as little modification as possible. Any modifications necessary for inclusion in the GDB should be documented. See Section 7.1.1 and 7.2.1 for details.

Task: **Copy external data to GDB Data Warehouse**
Responsible Party: KCGIS Center
Communication: Tech. Comm.; standard data change protocols
Deadline: 6 weeks

Task: **Determine level of use of coverage external data by analysts/users.**
Responsible Party: KCGIS Center; Migr. Wkgp.
Communication: Tech. Comm.

Deadline: 8 weeks

Task: **Remove external data from coverage data warehouse (/plibrary) if feasible (see above). Otherwise develop timeline and methodology for later removal.**
Responsible Party: KCGIS Center
Communication: Migr. Wkgp., Tech. Comm.
Deadline: (removal: 1 month after copy above)

Task: **Devise long-term methodology for converting incoming external coverage data.**
Responsible Party: KCGIS Center
Communication: Migr. Wkgp., Tech. Comm.
Deadline: 12 weeks +

Goal D3: Migrate Imagery to the GDB Data Warehouse

Description: Convert existing imagery to SDE, develop procedures for incoming imagery. See Section 7.2.1.

Task: **Load new and existing imagery into the GDB Data Warehouse; ensure that it is accessible to all agencies**
Responsible Party: KCGIS Center
Communication: Tech. Comm.; GIS User Group; ZZGrp_GIS_DataNews
Deadline: unknown

Task: **Determine timeline for deletion of legacy imagery library.**
Responsible Party: KCGIS Center; Migr. Wkgp.
Communication: Tech. Comm.; GIS User Group; ZZGrp_GIS_DataNews
Deadline: unknown

Task: **Implement deletion of legacy imagery library.**
Responsible Party: KCGIS Center
Communication: Tech. Comm.; GIS User Group; ZZGrp_GIS_DataNews
Deadline: unknown

Goal D4: Create Data Design

Description: Design layer relationships, topology rules, relationships for core and ancillary data layers that are to be migrated. Pay attention to barriers and impediments to agency business needs.

It must be understood that the cadastral database will not be modeled or migrated as a part of this effort. If we can assume that the parcel layer will not change drastically, we can design around the lack of the full cadastral data model, of which the parcel layer is a part.

Task: **Determine the best way to design around the cadastral database**
Responsible Party: KCGIS Center, Migr. Wkgp.
Communication: Tech. Comm.

Deadline: 12 weeks

Task: **Design data structures for core layers (parcel, districts, planning, transit, hydro)**
Responsible Party: KCGIS Center, AppDev Group
Communication: Tech. Comm.
Deadline: 20 weeks

Task: **Design data structures for ancillary layers (all others)**
Responsible Party: KCGIS Center, Migr. Wkgp.
Communication: Tech. Comm.
Deadline: 20 weeks +

Task: **Create plan for synchronizing production data with the data warehouse**
Responsible Party: KCGIS Center, Migr. Wkgp.
Communication: Tech. Comm.
Deadline: 12-20 weeks

Goal D5: Define Structure, Access, and Update Protocols for Production Server(s)

Description: The design should be based on existing limitations to network connections, existing SDE servers at agency sites, agency needs, and reasonable expectations of load. Note that this structure will not include the cadastral data model, but will assume the presence of the parcel layer.

Task: **Define structure, access and update protocols for the production server(s)**
Responsible Party: Migr. Wkgp.
Communication:
Deadline: 16 weeks

Goal D6: Implement and Test Prototype SDE Production Geodatabase

Description: Implement and test a prototype enterprise SDE production geodatabase, using copies of core data layers. Ensure that stewards can connect to their data, edit it, and publish edited data to the data warehouse. Devise and publish methodology and appropriate guidelines for stewards, developers and analysts. Note that this will not include the cadastral data model, but will assume the presence of the parcel layer.

Task: **Implement and test prototype SDE production geodatabase**
Responsible Party: KCGIS Center
Communication: Migr. Wkgp., Tech. Comm., AppDev Group
Deadline: 24 weeks

Goal D7: Optimize and Migrate Internally-Maintained Data to the Production Geodatabase

Description: Data migration. See Section 7.

Task: **Determine layer dependencies and prioritize layers and layer groups to migrate based on agency needs**
Responsible Party: Migr. Wkgp., Tech. Comm.
Communication: Publish to website
Deadline: 6-8 weeks

Task: **Determine which Optimization Option to pursue (see Section 5.5.1)**
Responsible Party: KCGIS Center, AppDev Group; Tech. Comm.
Communication: internal
Deadline: 0

Task: **Design, implement, and test optimization processes based on a set of prototype layers**
Responsible Party: KCGIS Center, AppDev Group
Communication: publish optimization guidelines when finalized
Deadline: 30 weeks

Task: **Optimize and migrate data**
Responsible Party: Agency Leads
Communication: standard data change protocols
Deadline: 30-52 weeks +

Task: **Remove migrated data from /plibrary**
Responsible Party: Migr. Wkgp., Agency Leads
Communication: standard data change protocols
Deadline: 30-52 weeks +

Goal D8: Ensure access to imagery

Description: Ensure that legacy users (ArcView 3.x, and MapObjects) have access to existing imagery if needed.

Task: **Test access to existing and new imagery using ArcView 3.2, 3.3, and MapObjects applications**
Responsible Party: KCGIS Center
Communication: Publish to website
Deadline: 12 weeks

11.8. Training

Goal T1: Develop Training Curriculum

Description: Develop a training curriculum for each of the six User Categories, using available, cost-effective, and appropriate courses from ESRI classroom, ESRI Virtual Campus, KCGIS Center courses and modules, and other sources.

Task: **Convene temporary workgroup to create the curriculum (this could easily be the Migration Workgroup)**

Responsible Party: PM
Communication: none
Deadline: 2 weeks

Task: **Develop training curriculum**
Responsible Party: Training Curricula workgroup
Communication: Notification of Technical Committee, Agency Leads, and Data Stewards, ZZGrp_GIS_All, and GIS User Group when task complete. Publication of curricula to KCGIS website, appropriate Public Folders,
Deadline: 12 weeks

Goal T2: Develop individual GIS Training Plans

Description: Ensure that each GIS user is aware of the training curricula, and allow them to make adjustments for their own situation.

Task: **Develop an individual GIS training plan for each user**
Responsible Party: Agency Leads
Communication: User
Deadline: flexible, depending on Agency

Goal T3: Train GIS Stewards and Developers

Description: Ensure that those who will be designing and implementing the new GIS software are given the skills to do so. Training schedules should be flexible and dependent on Agency needs; however, it is preferable to have GIS staff who are in lead or user support roles trained before end users begin their training.

Task: **Train Developers and Data Stewards**
Responsible Party: Agency Leads
Communication: none
Deadline: flexible, depending on Agency

Task: **Allow Developers and Data Stewards adequate ramp-up time to get used to software**
Responsible Party: Agency Leads
Communication: none
Deadline: flexible, depending on Agency

Goal T4: Train GIS Analysts, SysAdmins, and Decision Makers

Description: Ensure that those who will be using new GIS software are given the skills to do so. Training schedules should be flexible and dependent on Agency needs; however, it is preferable to have GIS staff who are in lead or user support roles trained first to facilitate the training of others.

Task: **Train Analysts and SysAdmins**
Responsible Party: Agency Leads

Communication: none
Deadline: flexible, depending on Agency

Task: **Train Decision Makers**
Responsible Party: Agency Leads
Communication: none
Deadline: flexible, depending on Agency

Goal T5: Train GIS Users

Description: Training for any given GIS end user should take place only after that user has been categorized and the determination made as to which software he/she will be using (ArcView 8.x, ArcIMS application).

Task: **Train End Users**
Responsible Party: Agency Leads
Communication: none
Deadline: flexible, depending on Agency

11.9. Licensing

Goal L1: Maximize cost efficiency of ArcGIS licensing

Description: Upgrading over 200 ArcView licenses to ArcGIS is cost prohibitive. See Section 6.8 for details

Task: **Create committee to study effacacy of license pooling and make recommendations to Technical Committee**
Responsible Party: Migr Wkgp., KCGIS Center License Manager
Communication: Tech. Comm.
Deadline: 12 weeks

Task: **Determine agency-wide license needs based on user categorization**
Responsible Party: KCGIS Center, Agency Leads
Communication: Tech. Comm.
Deadline: 12 weeks

Task: **Determine necessary license configuration and access scenarios**
Responsible Party: KCGIS Center, Agency Leads
Communication: Tech. Comm., Migr. Wkgp.
Deadline: 16 weeks

Task: **Implement the chosen license configuration scenarios**
Responsible Party: KCGIS Center, Agency Leads
Communication: Tech. Comm., Migr. Wkgp.
Deadline: 36 weeks

Goal L2: Determine need for additional short-term licenses while migrating

Description: There will likely be a short-term shortage of licenses as users continue to use the old system while experimenting and getting used to the new.

Task: **Determine the need for additional short-term licenses while migrating**
Responsible Party: Migr Wkgp., KCGIS Center License Manager
Communication: Tech. Comm.
Deadline: 12 weeks

Task: **Work with ESRI to implement short-term licensing solution**
Responsible Party: KCGIS Center License Manager
Communication: Tech. Comm., Migr. Wkgp.
Deadline: 20 weeks

11.10. Enterprise Applications

Goal E1: Migrate enterprise front-end applications to ArcGIS format

Description: For each application listed: determine need, design, implement, test and deploy. Create and publish user documentation.

Task: **Prioritize existing enterprise applications based on agency business needs. Determine additional needs for enterprise applications and add to priority list**
Responsible Party: KCGIS Center
Communication: Tech. Comm., Migr. Wkgp., GIS User Group
Deadline: 10 weeks

Task: **LibTool (AVLib): likely first candidate**
Responsible Party: KCGIS Center
Communication: Tech. Comm., Migr. Wkgp., GIS User Group
Deadline: Before GDB DW is deployed

Task: **ParcelTools**
Responsible Party: KCGIS Center
Communication: Tech. Comm., Migr. Wkgp., GIS User Group
Deadline: Preferably before GDB DW is deployed

Task: **Sitetool (StewardTool)**
Responsible Party: KCGIS Center
Communication: Tech. Comm., Migr. Wkgp., GIS User Group
Deadline: Before Production GDB is deployed

Goal E2: Support legacy applications while migration is in progress

Description: For each application listed: determine need, formulate support options,

publish sunset date.

Task: **AVLib**
Responsible Party: KCGIS Center, Agency Leads
Communication: Tech. Comm., Migr. Wkgp., GIS User Group
Deadline: most likely indefinite

Task: **ParcelTools**
Responsible Party: KCGIS Center, Agency Leads
Communication: Tech. Comm., Migr. Wkgp., GIS User Group
Deadline: most likely indefinite

Task: **Sitetool**
Responsible Party: KCGIS Center, Agency Leads
Communication: Tech. Comm., Migr. Wkgp., GIS User Group
Deadline: end of migration

Task: **Metadata tools (Doctool)**
Responsible Party: KCGIS Center, Agency Leads
Communication: Tech. Comm., Migr. Wkgp., GIS User Group
Deadline: end of data migration

Task: **Metadata output (Docgen)**
Responsible Party: KCGIS Center, Agency Leads
Communication: Tech. Comm., Migr. Wkgp., GIS User Group
Deadline: end of data migration

Task: **Maint/Rec, Integrate, Update (included for completeness – no changes likely to these until the cadastral migration is completed)**
Responsible Party: KCGIS Center, Agency Leads
Communication: Tech. Comm., Migr. Wkgp., GIS User Group
Deadline: unknown

Goal E3: Migrate targeted ArcView 3.x users to ArcIMS

Description: Determine the processes, guidelines and enterprise applications needed to migrate current ArcView 3.x users to thin-client ArcIMS applications.

Task: **Target specific users (or groups of users) for potential migration to ArcIMS applications**
Responsible Party: KCGIS Center, Agency Leads
Communication: Tech. Comm., Migr. Wkgp., GIS User Group
Deadline: 16 weeks

Task: **Determine processes, guidelines, and enterprise applications needed to migrate these users**
Responsible Party: KCGIS Center, Agency Leads
Communication: Tech. Comm., Migr. Wkgp., GIS User Group

Deadline: 24+ weeks

Task: **Design, build, test needed enterprise ArcIMS applications**
Responsible Party: KCGIS Center, Agency Leads
Communication: Tech. Comm., Migr. Wkgp., GIS User Group
Deadline: unknown

11.11. Budgeting

Funds for KCGIS Center staff time will come out of the O&M budget. Funds for agency staff time and resources will come out of agency GIS budgets. A comprehensive discussion of budgeting in King County can be found in the *2004 GIS Operations and Maintenance Plan*.

Appendix A: Definitions

A.1 Agencies

Agency abbreviations and general GIS use levels used in this document:

Agency	Abbreviation	Use [1]
Budget Office	Budget	Low
Department of Assessments	KCA	High *
Department of Development and Environmental Services	DDES	High
Department of Public Health	PubHealth	Mid
DES, Facilities Management	FMD	Low *
DES, Office of Emergency Management	OEM	Mid
DES, Records, Elections, Licensing	REALS	High
DNRP, GIS Center (enterprise capacity)	KCGIS Center	N/A
DNRP, GIS Center (user agency capacity)	GISC	High *
DNRP, Parks & Recreation	Parks	Mid
DNRP, Solid Waste	SWD	Low
DNRP, Wastewater Treatment	WTD	Med
DNRP, Water and Land Resources	WLRD	High
DOT, Airport	KCIA	Low
DOT, Road Services	Roads	Mid
DOT, Transit	Transit	High *
King County Sheriff's Office	Sheriff	Low
Metropolitan King County Council	Council	Low

[1] Asterisk denotes use levels determined by self-categorization; otherwise use level was determined by evaluation of survey results.

Agencies, Low-use – Those which are either just starting out with GIS, use it for limited functions, or not necessarily every day. They generally they lack a dedicated (full-time) GIS staff, and generally have no end-users. Low-use agencies do not maintain enterprise GIS data, and may not maintain any GIS data of their own. They generally use GIS on a by-project basis for mapping and analysis.

Agencies, Mid-use – Those which may use GIS heavily and/or every day, but GIS is not an integrated part of the agency's business – it's more of an adjunct or a very useful tool. They may have one or two dedicated GIS staff to support a low number of end-users. Mid-use agencies mostly use GIS on a by-project basis, but may have some incorporation of GIS into greater agency business. They maintain their own GIS layers locally for mapping and analysis, and may maintain enterprise data, but not at the volume of the high-use agencies. GIS use in these agencies is likely dynamic – either experiencing growth, or are planning growth, or are possibly even shrinking.

Agencies, High-use – Those which use GIS heavily, every day. GIS is an integrated part of their business, and loss of GIS would significantly impact the agency as a whole. They have relatively many GIS staff and many end-users that rely on departmental GIS to do their

jobs. High-use agencies maintain large amounts of enterprise data, as well as their own GIS data.

KCGIS Center vs. GISC – While the KCGIS Center is tasked as the administrative agency for enterprise GIS, it also has a role as a user agency. Therefore, it will be referred to in this document as "KCGIS Center" when the context involves its enterprise administrative capacity, and referred to as "GISC" when speaking of it in a user agency capacity.

A.2 Users and groups

End user (User) – one whose primary job description is not GIS-oriented but who may use GIS heavily in day-to-day work

GIS staff – one whose primary job description is GIS-oriented.

KCGIS Center ETO staff – Enterprise and Technical Operations staff.. Consists of the DBA, applications developers, and Cadastral Data Coordinator.

KCGIS Technical Committee (GIS Technical Committee) – Consists of representation from all 16 participant agencies plus the KCGIS Center. The KCGIS Technical Committee develops the annual GIS O&M plan, addresses programmatic issues, and makes recommendations to the KCGIS Oversight Committee regarding GIS procedures, standards, and work initiatives.

Migration Workgroup – consists of technical representatives from the high-use agencies and the KCGIS Center Enterprise Workgroup. This group is tasked with the major activities of the migration that require cross-agency coordination, including data modeling, determining agency needs, facilitating communication, ensuring (with the Technical Committee) that agency tasks are carried out in a timely basis, and other tasks as needed. It will be moderated by the Software Migration Project Manager, and will report to the GIS Technical Committee. An ancillary group consists of technical representatives of mid- and low- use agencies. This group receives all communications, but active participation is not required.

A.3 Applications

Enterprise application – one which is available and appropriate for everyone using GIS in King County (i.e., Sitetool).

Non-enterprise application – one which is available or appropriate for users in a limited number of agencies (i.e., StreetTool; Base2).

In-house application – One developed for use by a single agency (i.e., certain Transit apps).

A.4 Licensing

Single-use license – a type ESRI software license that consists a single seat and runs only on the machine on which the software is installed.

Standalone license – same as a single-use license.

Concurrent-use license – a type of ESRI software license that is served by a license manager. Concurrent-use licenses can be used by anyone with access to the server that hosts the license manager. The server may host one or more concurrent-use licenses on the same license manager.

Floating license – same as a concurrent-use license.

Node-locked license – a type of ESRI software license that is served by a license manager. Node-locked licenses require that the user be logged onto the server that hosts the license. Node-locked licenses are only available in packs of three seats; that is, one node-locked license allows three users to access the software at the same time. ESRI no longer offers node-locked Arc/Info licenses for purchase.

A.5 Data

Materialized View – An Oracle database object available at version 8i and later. "Materialized views improve query performance by precalculating expensive join and aggregation operations on the database prior to execution time and storing the results in the database. The query optimizer can use materialized views by automatically recognizing when an existing materialized view can and should be used to satisfy a request. It then transparently rewrites the request to use the materialized view. Queries are then directed to the materialized view and not to the underlying detail tables. In general, rewriting queries to use materialized views rather than detail tables results in a significant performance gain." -source: Oracle Technet: *http://download-west.oracle.com/docs/cd/A87860_01/doc/server.817/a76994/mv.htm#38255*

Production systems (Production) – An area on a central server that contains data stored in a database with SDE and/or file-based data accessible for editing by data stewards. Data in production is not to be considered the definitive or authoritative version, but rather is in review/edit status pending publishing to the data warehouse.

RDBMS (Relational Database Management System) – A program that allows users to create, update and administer a relational database.

RECDNET – Abbreviation for the King County cadastral base GIS layer. When considered in general terms, RECDNET includes the annotation layer, RECDANNO.

Spatial Data Warehouse (Data Warehouse) – Authoritative, read-only version(s) of shared data (layers, tables). The data warehouse can consist of multiple data formats in multiple locations, provided that a mechanism is in place to index and serve the data. Data in the data warehouse has passed standard QA/QC procedures and is accompanied by adequate metadata.

A.6 Other King County GIS Publications

Best Practices for GIS Within King County **(Best Practices Document)** – Outlines and details suggested best practices for GIS in King County. Can be found online at: http://www.metrokc.gov/gis/kb/Content/BestPractices.htm

GIS Production Operation and Maintenance Plan **(O&M Document)** – Outlines and details the operations and maintenance practices and plan for enterprise GIS in King County. Includes status and workpkans for each GIS agency and the KCGIS Center. Updated annually. Can be found online at: http://www.metrokc.gov/gis/kb/Content/OandM.htm.

Appendix B: KC GIS Agency Survey

Current Use:

Describe general business use:

Describe current budget situation:

Hardware:
What is the platform / OS on your workstations? (do you run in a mixed environment? Why?)
Do you have one or more GIS servers?
    What platform / OS / use for each
Licenses:
Arc7:
Arc8:
ArcView 3.x:
SDE:
Extensions: Spatial Analyst 3D analyst Network COGO TIN Grid ArcPress others
RDBMS (Oracle, SQL Server):
Other (list)

People
Number of GIS professionals in the agency:
Does the agency have a "GIS Unit" that is specifically tasked with providing GIS service to other units in the agency
    How many employees:
Number of end-users (non-GIS professionals):
    Who supports your end-users
In general, how many people in your agency use GIS:
    every day?
    at least once a week?
    less (describe)
How/when/through whom do you provide GIS training?

Software:
Use levels: who and how often:
    Arc7:
    Arc8
    ArcView 3.x
    Extensions: Spatial Analyst, 3D analyst, Network, COGO, TIN, Grid, ArcPress, Others
    Other (list)

Applications:
How often are these enterprise applications used?

	by GIS professionals?	by end-users
AVLib		
ParcelTools		
Sitetool (Newname, Staff, etc.)		
Doctool		
MaintRec		
Keytool		
iMAP		
Parcel Viewer		
Other		

What non-enterprise applications do you use?
List and describe: purpose, audience, frequency

Do you develop your own applications?
List and describe: purpose, audience, frequency

Data:
Where / how do you access GIS information?

How do you connect your business data to GIS data (enterprise and/or in-house)?

How often do you connect directly to enterprise GIS data servers (/plibrary, /plibrary2, SDE)?

Future:

General change in the next few years:
Do you foresee a change in your GIS business definition / needs in next few years?
Growth rate of staff?
Will you be obtaining new licenses / software?
What does your future budget look like (do you expect $ in next 2 years for)?
- New hardware?
- New software?
- Data creation / maintenance?
- Analysis?
- Staff training?

In general, what do you see as the biggest challenge to your GIS business in the next few years?

The Migration:
In general, how aware are you / your staff of the functionality offered in the new versions of ArcGIS?
What advantages do you see to the new versions of ArcGIS?
What disadvantages do you see to the new versions of ArcGIS?
Do you feel that a migration is necessary?
- For you?
- For the enterprise?
- Why / why not?

Do you have a migration plan? (may I have a copy?)

Have you already moved some/all of your operation to ArcGIS?
- Yes
  - What version (from – to)?
  - Will you be moving everyone (if not, why)
  - What's your timeline?
  - how is it working out for you?
    - Technical problems, gripes?
    - What do you like about it?
    - How has it changed the way you do business?
    - Has it helped or hindered your operation?
    - What was the ramp-up time for you staff?
    - Do you use ArcSDE – how, frequency?
- If not do you intend to do so? (if not, why?)
  - do you have a timeline?
  - Is it based on the enterprise migration? If so, is it before, during or after?

Business:

How do you think that the migration will affect your user base?
How do you think that the enterprise migration will affect the way you do business?
What do you see within your business need/use that will cause special problems?
What do you feel will be the biggest challenge?
- For your agency?
- For the enterprise?

Data:

Do you intend to migrate your in-house data to GDB format?
- If so, when
- If not, why?

Given that a GDB-based enterprise data warehouse is a necessity and inevitable:
- Do you want input into its implementation (any thoughts now)?
- What difficulties do you foresee attaching / using the data (technical / business)
- What timeline do you see for full implementation (GDB DW as primary data source)?

If you maintain your own RDBMS, what complications do you foresee during / after migration (either on the migration or on the RDBMS)?

Applications:

If you develop / maintain your own applications, what is your plan for migration?
In general, what sorts of enterprise applications would you like to see?
- List:
- Web-based applications?
- Others?

The GIS Center

What type / amount of support do you expect from the GIS Center?
- help migrating?
- training?
- data (storage / conversion / creation / maintenance)?
- applications?
- other?

What else?

Do you have any issues or concerns that I haven't brought up?

Do you want the opportunity to see notes once they've been transcribed?

Any other comments?

Appendix C: Minimal Metadata Requirements

(set forth by the King County GIS Best Practices Committee)

Required:

- Identification Information:
  - Citation
    - Originator (Agency and Contact person)
    - Publication Date
    - Geospatial Data Presentation Form
  - Description
    - Abstract
    - Purpose
    - Access Constraints
    - Use Constraints
    - Native Data Set Format
  - Time Period
    - Currentness Reference and Date
  - Status
    - Progress
    - Update Frequency
  - Spatial Domain
    - Bounding Coordinates (N,S,E,W)
  - Keywords
  - Point of Contact
    - Agency and Contact person (name, organization, phone number required, email address recommended)
- Spatial Reference:
  - Horizontal Coordinate System Information
- Entity and Attribute:
  - For each entity type, Label is required, Definition is recommended. For each attribute within each entity type, Label and Definition are required
- Metadata Reference:
  - Metadata Date
  - Metadata Standard Name
  - Metadata Contact Person (name, organization, phone number required, email address recommended).

Recommended:

- Data Quality Information:
  - Attribute Accuracy Report
  - Completeness Report
  - Positional Accuracy: Horizontal Positional Accuracy (Vertical also if needed)
  - Source Information
  - Process Step: Process Definition
- Distribution Information
  - Distributor: Contact Person (name, organization, phone number required, email address recommended)
  - Distribution Liability

Optional if available and as time permits:

- Spatial Data Organization Information
- Other subsections of the FGDC standard that are not explicitly listed above.

Appendix D: Licensing Cost Tables

Note: There is no way to present all possible licensing scenarios. The tables below illustrate the migration of all instances of a type of license without consideration of alternate ways to meet user needs. It is a near-certainty that all licenses – especially all ArcView 3.x licenses – will not be upgraded, so totals in the below tables should be used for illustrative as opposed to planning purposes.

D.1. Tables for Arc/Info

Table D.1: Current Cost of Arc/Info 7.x

	Node-locked: 3-pack				Floating				Totals
	Primary		Secondary		Primary		Secondary		
Annual Maintenance	Licenses	3800	Licenses	1450	Licenses	2050	Licenses	1040	
Agency									
KCA	1	3800	2	2900					6700
REALS					1	2050			2050
GISC	1	3800	4	5800	1	2050	2	2080	13730
Transit					1	2050	2	2080	4130
Totals *	**6**	**7600**	**18**	**8700**	**3**	**6150**	**4**	**4160**	**26610**
Seats									**31**

* One node-locked license yields three seats, and therefore three ArcGIS licenses upon upgrade.

Table D.2: Current Cost of ArcInfo 8.x

	Concurrent-use				Standalone	Totals
	Primary		Secondary			
Annual Maintenance	Licenses	2050	Licenses	1040	0	
Agency						
DDES	1	2050	2	2080		4130
GISC	1	2050	6	6240		8290
Parks			1	1040		1040
WTD			1	1040		1040
WLRD	1	2050	3	3120		5170
Roads	4	8200				8200
Transit	1	2050	1	1040		3090
Totals	**8**	**16400**	**14**	**14560**	**0**	**30960**
Seats						**22**

Table D.3: Converting Arc/Info 7.x to ArcInfo 8.x

Agency	Total Primary		Total Secondary		Total Licenses	Total
	Licenses	2050	Licenses	1040		
KCA	1	2050	8	8320	9	10370
DDES	1	2050	2	2080	3	4130
REALS	1	2050	0	0	1	2050
GISC	3	6150	22	22880	25	29030
Parks	0	0	1	1040	1	1040
WTD	0	0	1	1040	1	1040
WLRD	1	2050	3	3120	4	5170
Roads	4	8200	0	0	4	8200
Transit	1	2050	4	4160	5	6210
Total	**12**	**24600**	**41**	**42640**	**53**	**67240**

Table D.4: Pooling ArcInfo 8.x Licenses – all licenses on one server

All licenses on one server				
	Primary		Secondary	
	Licenses	2050	Licenses	1040
	6	12300	47	48880
Total				**61180**
Cost to individual agencies				
Agency	Licenses	Cost-pooled*	Cost-non-pooled	Savings*
KCA	9	10389	10370	-19
DDES	3	3463	4130	667
REALS	1	1154	2050	896
GISC	25	28858	29030	172
Parks	1	1154	1040	-114
WTD	1	1154	1040	-114
WLRD	4	4617	5170	553
Roads	4	4617	8200	3583
Transit	5	5772	6210	438
Total	**53**	**61180**	**67240**	**6060**

* Rounded to the nearest dollar

D.2. Tables for ArcView

Table D.5: Converting ArcView 3.x to Standalone ArcView 8.x

Agency	ArcView 3.x Licenses	Cost to convert to Standalone ArcView 8.x
		600
Budget	1	600
KCA	22	13200
DDES	20	12000
PubHealth	8	4800
FMD	2	1200
OEM	3	1800
REALS	5	3000
GISC	20	12000
Parks	6	3600
SWD	2	1200
WTD	5	3000
WLRD	59	35400
KCIA	0	0
Roads	35	21000
Transit	27	16200
Sheriff	4	2400
Council	2	1200
Total	**221**	**132600**

Table D.6: Upgrading ArcView 3.x to Concurrent-use ArcView 8.x

Agency	ArcView 3.x Licenses	Cost to convert to Concurrent ArcView 8.x
		2080
Budget	1	2080
KCA	22	45760
DDES	20	41600
PubHealth	8	16640
FMD	2	4160
OEM	3	6240
REALS	5	10400
GISC	20	41600
Parks	6	12480
SWD	2	4160
WTD	5	10400
WLRD	59	122720
KCIA	0	0
Roads	35	72800
Transit	27	56160
Sheriff	4	8320
Council	2	4160
Total	**221**	**459680**

Table D.7: Annual Maintenance for all ArcView 8.x Licenses (no pooling) *

Agency	Total Primary		Total Secondary		Total Licenses	Total
	Licenses	700	Licenses	500		
Budget	1	700	0	0	1	700
KCA	2	1400	20	10000	22	11400
DDES	2	1400	18	9000	20	10400
PubHealth	1	700	7	3500	8	4200
FMD	1	700	1	500	2	1200
OEM	1	700	2	1000	3	1700
REALS	1	700	4	2000	5	2700
GISC	3	2100	27	13500	30	15600
Parks	1	700	5	2500	6	3200
SWD	1	700	1	500	2	1200
WTD	1	700	4	2000	5	2700
WLRD	7	4900	67	33500	74	38400
KCIA	0	0	0	0	0	0
Roads	4	2800	31	15500	35	18300
Transit	3	2100	29	14500	32	16600
Sheriff	1	700	3	1500	4	2200
Council	1	700	1	500	2	1200
Total	**31**	**21700**	**220**	**110000**	**251**	**131700**

* Does not include the four standalone licenses located in Budget (1), KCA (1), and KCIA (2).

Table D.8: Pooling ArcView 8.x Licenses – all licenses on one server

All licenses on one server				
	Primary		Secondary	
	Licenses	700	Licenses	500
	26	18200	225	112500
Total				**130700**
Cost to individual agencies				
Agency	Licenses	Cost-pooled*	Cost-non-pooled	Savings*
Budget	1	521	700	179
KCA	22	11456	11400	-56
DDES	20	10414	10400	-14
PubHealth	8	4166	4200	34
FMD	2	1041	1200	159
OEM	3	1562	1700	138
REALS	5	2604	2700	96
GISC	30	15622	15600	-22
Parks	6	3124	3200	76
SWD	2	1041	1200	159
WTD	5	2604	2700	96
WLRD	74	38533	38400	-133
KCIA	0	0	0	0
Roads	35	18225	18300	75
Transit	32	16663	16600	-63
Sheriff	4	2083	2200	117
Council	2	1041	1200	159
Total	**251**	**130700**	**131700**	**1000**

* Rounded to the nearest dollar.

D.3. Tables for Extensions

Table D.9: Current COGO Licenses

	Node-Locked Primary		Floating Primary		Floating Secondary		Totals
Annual Maintenance	Licenses	900	Licenses	500	Licenses	200	
Agency							
KCA	1	900	1	500	1	200	1600
GISC			1	500	8	1600	2100
REALS			1	500	0	0	500
Roads			1	500	0	0	500
Totals	**3**	**900**	**4**	**2000**	**9**	**1800**	**4700**

Table D.10a: Upgrading Spatial Analyst

	ArcView 3.x Licenses	Cost to Convert	Maintenance		Total Annual Maintenance
		600	Primary 500	Secondary 200	
Agency					
Budget	1	600	500		500
KCA	1	600	500		500
DDES	1	600	500		500
OEM	1	600	500		500
GISC	3	1800	500	600 *	1100
WLRD	3	1800	500	400	900
WTD	1	600	500		500
Roads	3	1800	500	400	900
Sheriff	4	2400	500	600	1100
Totals	**18**	**10800**	**4500**	**2000**	**6500**

* Incorporates maintenance cost for one existing GRID license.

Table D.10b: Pooling Spatial Analyst

	Spatial Analyst			
	Primary		Secondary	
	Licenses	500	Licenses	200
	2	500	17	3400
Total				3900
Cost to individual agencies				
Agency	Licenses	Cost-pooled	Cost-non-pooled	Savings
Budget	1	205	500	295
KCA	1	205	500	295
DDES	1	205	500	295
OEM	1	205	500	295
GISC	4	821	1100	279
WLRD	3	616	900	284
WTD	1	205	500	295
Roads	3	616	900	284
Sheriff	4	821	1100	279
Total	**19**	**3900**	**6500**	**2600**

Table D.11a: Upgrading 3D Analyst

	ArcView 3.x Licenses	Cost to Convert	Maintenance		Total Annual Maintenance
			Primary	Secondary	
		600	500	200	
Agency					
PubHealth	1	600	500		500
GISC	1	600	500	200*	700
WTD	1	600	500		500
WLRD	0		500**		500
Roads	2	1200	500	400**	900
Transit	0	0	500**		500
Totals	**5**	**3000**	**3000**	**600**	**3600**

* Incorporates maintenance cost for one existing TIN license.
** Incorporates maintenance cost for one existing ArcGIS 3D Analyst license

Table D.11b: Pooling 3D Analyst

3D Analyst				
	Primary		Secondary	
	Licenses	500	Licenses	200
	1	500	8	1600
Total				2100
Cost to individual agencies				
Agency	Licenses	Cost-pooled	Cost-non-pooled	Savings
PubHealth	1	233	500	267
GISC	2	467	700	233
WTD	1	233	500	267
WLRD	1	233	500	267
Roads	3	700	900	200
Transit	1	233	500	267
Total	**9**	**2100**	**3600**	**1500**

Table D.12a: Upgrading Network Analyst

	Network Analyst				
	ArcView 3.x Licenses	Cost to Convert	Maintenance		Total Annual Maintenance
			Primary	Secondary	
		600	500	200	
Agency					
GISC	2	1200	500	600 *	1100
Roads	1	600	500	0	500
Transit	0	0	500 **	400 ***	900
Totals	3	1800	1500	1000	2500

* Incorporates maintenance cost for one existing ArcGIS Network Analyst license, and one existing Arc/Info 7.x license.

** Incorporates maintenance cost for one existing ArcGIS Network Analyst license.

*** Incorporates maintenance cost for two existing Arc/Info 7.x Network Analyst licenses

Table D.12b: Pooling Network Analyst

	Network Analyst			
	Primary		Secondary	
	Licenses	500	Licenses	200
	1	500	7	1400
Total				**1900**
Cost to individual agencies				
Agency	Licenses	Cost-pooled	Cost-non-pooled	Savings
GISC	4	950	1100	150
Roads	1	238	500	150
Transit	3	713	900	150
Total	**8**	**1900**	**2500**	**450**

Table D.13: Upgrading ArcPress

	Conversion to Concurrent-Use			Conversion to Single-Use	
	Licenses	Cost to Convert	Annual Maintenance	Licenses	Cost to Convert
		1000	200		100
Agency					
DDES	1	1000	200	1	100
REALS	1	1000	200	1	100
GISC	2	2000	400	2	200
WTD	1	1000	200	1	100
WLRD	1	1000	200	1	100
Roads	4	4000	800	4	400
Totals	**10**	**10000**	**2000**	**10**	**1000**